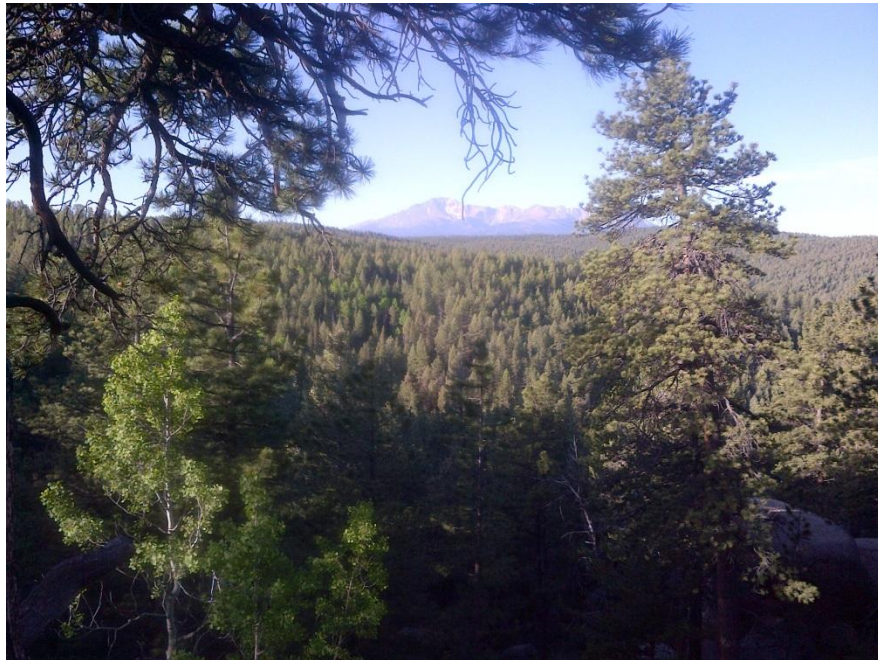


Upper Monument Creek EIS

Forest Vegetation Resource Report



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Pike and San Isabel National Forest
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Introduction

The 70,600 acre Upper Monument Creek (UMC) project is located within the Pikes Peak Ranger District on the Pike National Forest in Colorado. From 1910 to current times suppression of both lightning and human caused fires has been the central focus on National Forest lands, which has effectively modified the fire regime in many areas. The UMC project area is a reflection of this suppression effort as only two fires have influenced the structure and development of the landscape. Fire suppression has not only modified the natural fire regime of Front Range forests, but it has also significantly impacted the distribution and structure of forest vegetation. Current forest vegetation conditions are capable of carrying uncharacteristically large and severe wildfires that negatively affect the integrity of ecological and social systems. The UMC project seeks to address these concerns by restoring forest vegetation to conditions that are more representative of historic patterns that were resistant and resilient to the influences of fire.

Affected Environment

Project Area

The 70,600 acre Upper Monument Creek (UMC) project is located within the Pikes Peak Ranger District on the Pike National Forest in Colorado and is almost entirely comprised of National Forest land (see Figure 1 below). Approximately 6,700 acres within the project area are privately owned, most of which are on the eastern edge of Woodland Park, but also contain Department of Defense lands which make up a small portion of the Air Force Academy. Additionally, there are approximately 4,400 acres of the USFS Manitou Experimental Forest and 3,400 acres of designated Colorado Roadless Area within the UMC analysis area. The UMC landscape is within the Rampart Mountain Range and contains numerous critical watersheds that supply drinking water to a variety of Front Range communities. The surrounding communities vary in size from largely urbanized areas such as Colorado Springs and Woodland Park, to smaller more rural communities like Monument and Palmer Lake.

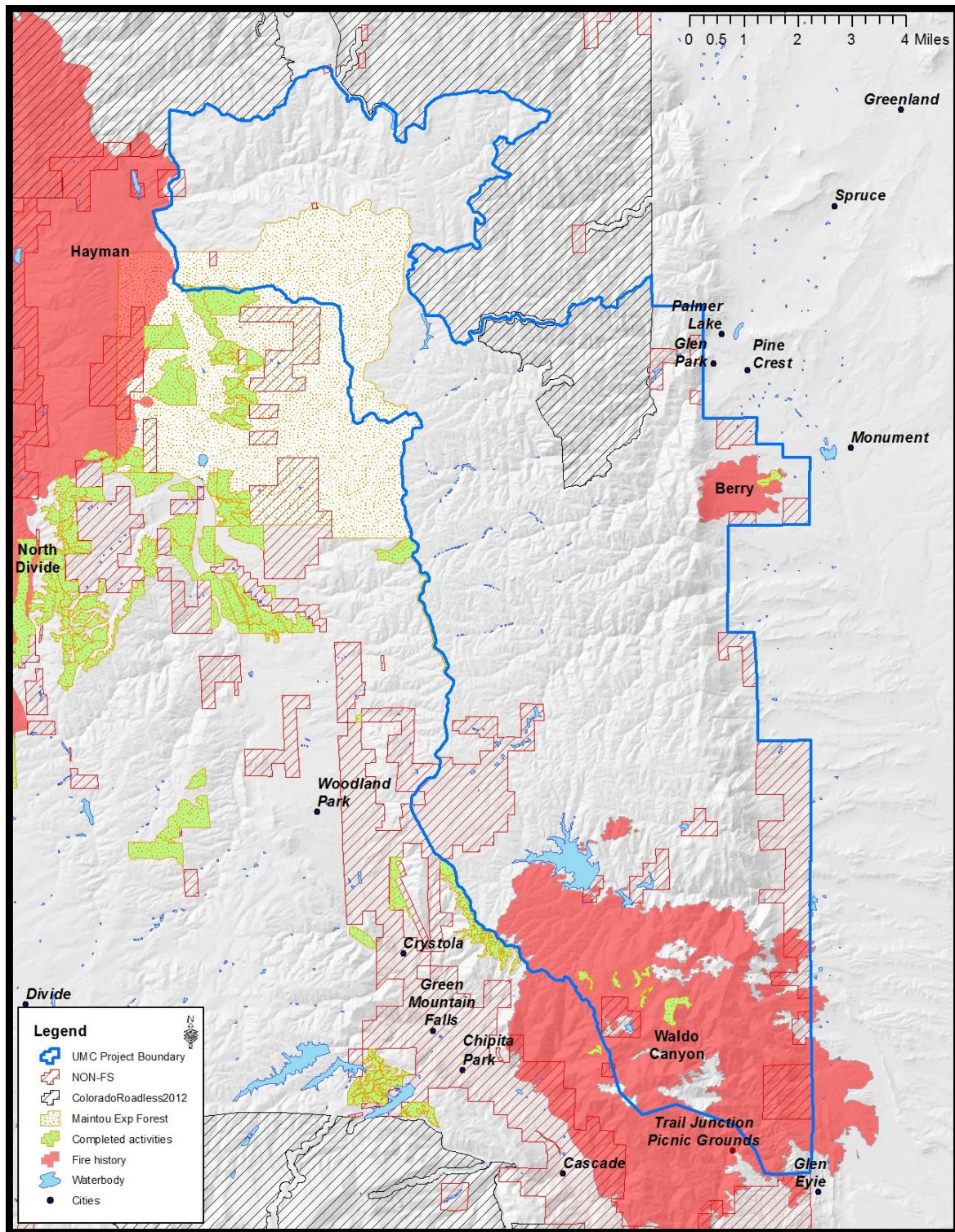


Figure 1. The UMC project area.

Project Area History

Historical use and development of the UMC landscape is similar to other areas within the Colorado Front Range. Prior to 1860 indigenous groups utilized these lands seasonally for decades although use patterns are a bit unclear (Vale 2002). After 1860 permanent settlement began to shape the area and this increase in population created a growing demand and interest in resources such as timber and metals. Seven years later, several large-scale mills were operating in the area to support the growing demands of a developing population. A report compiled in 1900 by U.S. Geological Survey employee John G. Jack stated that approximately 75 percent of the forests around Pikes Peak had been logged, burned, or both and were described as being some of the most damaged forests in the nation (Jack 1900).

In an attempt to ameliorate some of the previous deleterious land uses, an aggressive reforestation program was started on the Pike National Forest in the early 1900s (Bates 1923). Seedlings used for this effort were typically from offsite genetics that were poorly adapted to growing conditions on the Front Range and many of these plantations are still visible on the landscape because of their short statured “tree farm” appearance. Concurrently the Pike National Forest was also experiencing heightened levels of fire suppression as highly motivated and effective efforts were being made across all National Forest to prevent fire from entering forested landscapes.

The recent history of the UMC project area is more defined by fire rather than resource extraction and use (see Figure 1 above). Few fires of significance took place in the UMC landscape between the mid-to-late 1900s. This cycle of relatively little fire activity was interrupted in 1989 when the Berry Fire burned 850 acres near the outskirts of the USFS Monument Fire Center. More recently the Waldo Canyon Fire burned just northwest of Colorado Springs which destroyed 346 homes and forced 32,000 residents to evacuate. Approximately 10,500 of the total 18,200 acres burned in the Waldo Fire fall within the UMC analysis area. Portions of the Waldo Canyon burn scar have experienced significant erosion and mass wasting due to the loss of slope stability with the removal of vegetation within these watersheds. Millions of dollars are being spent annually by communities to protect and restore their watershed infrastructure damaged by the Waldo Canyon fire (CSU 2014, Elpasaco 2014).

There has been essentially no significant management within the UMC landscape. Select areas within the Waldo have been treated with erosion prevention barriers to stabilize hillsides and hazard trees have been treated along the main arterial route (Nation Forest System Road 300). Currently efforts are underway to treat approximately 130 acres of hazard trees from the Waldo Canyon Fire within the Rampart Reservoir area. A small portion (approximately 180 acres) of the Waldo burn were planted in 2014 with a mix of ponderosa pine and Douglas-fir seedlings to facilitate stand development in areas of high burn severity. Approximately 970 acres of vegetation management has occurred along the western boundary of the project area. Treatments in these areas range from variable density thinnings, to opening creation, to understory removal and occur mainly in the ponderosa pine-Douglas-fir forest type.

Existing Condition

Analysis Methods

Data for this section was taken from corporate data bases (spatial and tabular) maintained by the Forest Service. A detailed preliminary analysis using the same corporate data was compiled by a team from the Upper Monument Creek Landscape Restoration Initiative which included participants from the Forest Service, The Nature Conservancy, Colorado State University, and

other state and private organizations. This analysis provides a comprehensive discussion of existing conditions within the UMC project area and was used heavily in summarizing existing conditions for this report.

Topography

The topography of the UMC landscape is typical of areas along the Colorado Front Range. The Rampart Range is an uplift that trends north and south, extending from Pikes Peak on the south to the Platte Canyon on the north (Moore 1992). It is essentially a block bounded by a fault on the east and the South Platte River on the west (Moore 1992). It is an exogenic, moderately dissected, sloping and rolling landform (Moore 1992). Elevations range from 7,000 feet to 10,000 feet above sea level. The terrain moves from rolling foothills along the eastern slope to steep mountainous hillsides incised by deep gulches in the transition zone between foothill and montane landforms. The majority of the project area is comprised of mountainous terrain that consists of valley bottoms, ephemeral and perennial channels, and a mix of gradual and steep hillsides broken by a relatively continuous network of ridgelines. Slopes are generally between 0 and 30 percent, but can also be greater than 40 percent along the eastern side of the project area and in gulches and deep draws.

Soils

Granite and associated igneous rocks of the Pikes Peak batholith are dominant through the UMC landscape (Moore 1992). The main rock type is Pikes Peak granite. It is pink to reddish, medium grained to coarse grained biotite or hornblende-biotite granite (Moore 1992). Fan alluvium, valley alluvium, and colluvium are throughout the area (Moore 1992). There are 31 different soil map units within the UMC project area, yet 67 percent of the total project area falls within the Sphinx-Rock Outcrop series.

Sphinx soils are typically found on mountainsides where slopes are generally 15-80 percent (Moore 1992). The Sphinx soils are shallow and somewhat excessively drained. Typically the surface layer is gravelly coarse sandy loam and below this is very gravelly loamy coarse sand. Ponderosa pine annual production on these soils typically ranges from 25-29 cubic feet per acre (Moore 1992). Rock outcrops are formed from Pikes Peak granite. Minor amounts of Aquolls and Guffey area also found in mixed in with this series at the base of slopes (Moore 1992).

This soils series is best suited to wildlife habitat, watershed, recreation, and limited timber production (Moore 1992). This series is very susceptible to erosion if the cover of vegetation and little is disturbed. The major limitations affecting the production and harvest of timber are a high susceptibility to erosion, low natural fertility, and depth to bedrock (Moore 1992). The coarse nature and lack of cohesion also makes these soils highly susceptible to post-fire erosion and debris flows.

Climate

The climate of the UMC landscape is heavily influenced by the mountainous terrain that defines the Colorado Front Range. Changes in elevation and topographical features have an impact on temperatures, wind patterns, and storm tracks in all seasons of the year (Doesken et al. 2003). Large seasonal and diurnal temperature swings are common throughout the area. At times during the summer months (June-July-August) winds shift to the southwest and bring hot, dry air from the desert southwest over the State (Doesken et al. 2003). Such hot spells are usually of short duration. Average summer maximum and minimum temperatures for the UMC project area are around 81°F and 46°F respectively (HPRCC 2014). During winter months (December-January-

February) diurnal temperature fluctuations are similar to summer pattern, but are often amplified by strong temperature inversions that occur throughout the winter (Doesken et al. 2003). Average winter maximum and minimum temperatures are around 46°F and 12°F respectively (HPRCC 2014). Annually project area average maximum and minimum temperatures are around 62°F and 29°F respectively (HPRCC 2014).

Distance from major sources of moisture (the Gulf of Mexico and the Pacific Ocean) is a limiting factor for precipitation (Doesken et al. 2003). Additionally, precipitation patterns are largely controlled by mountain ranges and changes in elevation. In summer, mountain peaks and ranges are effective thunderstorm generators whenever regional air masses are sufficiently moist (Doesken et al. 2003). Localized thunderstorms can form nearly every afternoon in and near the mountains. The last half of July and much of August are particularly prone to mountain thunderstorms while June is typically a much drier month in the high country. Snow and soft hail are possible from mountain storms even in July and August (Doesken et al. 2003). Average annual precipitation is approximately 16 inches, with 42 percent of this rainfall coming in the summer months (HPRCC 2014).

Precipitation increases with elevation in both winter and summer but the elevation effect is greatest in mid-winter. High peaks and mountain ranges generally receive the majority of their precipitation during with winter months in the form of snowfall (Doesken et al. 2003). The UMC receives on average approximately 56 inches of snow a year, with significant snow fall accumulations from November to April (HPRCC 2014). However, historically the heaviest snow months are March and April (HPRCC 2014).

Wind patterns in the mountains are predominantly controlled by topography. Mountain-valley circulations are common with winds often blowing up the valley from lower to higher elevation during the day as air masses warm, subsequently reversing and blowing down the valleys at night as air masses cool (Doesken et al. 2003). Mountains form a substantial block to regional air motion causing winds in most valleys west of the Continental Divide to be very light, while winds along and east of the Continental Divide are much stronger and typically blow from a westerly direction much of the cool half of the year (Doesken et al. 2003).

Tornadoes have been found to be quite common with the improvement in severe storm detection in recent decades (Doesken et al. 2003). Tornadoes are relatively rare in the mountains and western valleys but do occur. Typically 40 tornadoes are confirmed annually throughout Colorado (Doesken et al. 2003). Most of these tornadoes are small and short lived, and usually reach only F0 or F1 intensity (Doesken et al. 2003). However, occasional strong tornadoes have been reported. In 2014 a tornado touched down just outside of Lake George, Colorado (approximately 3 air miles east of the project area) and blew down approximately 30 acres of mature trees.

Lightning is one of the greatest weather hazards in Colorado. Unlike tornadoes that are most common in selected areas of the state, lightning occurs throughout the state (Doesken et al. 2003). Lightning strike statistics indicate that the most lightning prone areas of Colorado are the high ground above tree line between Denver and Colorado Springs (Doesken et al. 2003). However, lightning strikes within forested landscapes is also quite common. Within the UMC project area the counties of Douglas, Teller and El Paso receive on average 11, 6, and 28 thousand air to ground lightning strikes per year respectively (NOAA 2014).

Watersheds

Watersheds are critical components of ecosystem and municipality function and health. Water from Colorado's forest supports a variety of uses including public drinking water, agriculture, industrial uses (including mining), recreation and habitat for aquatic life (USFS 2008). Forests exert a strong influence on the quantity and quality of water within watersheds by protecting soil and preventing erosion, enhancing soil moisture storage and groundwater recharge, reducing flooding, filtering contaminants and maintaining the plant communities that also contribute to this process (CSFS 2009). Nearly all of these watersheds are designated in the Colorado Statewide Forest Resource Assessment as a high priority for drinking water and also as watersheds as high risk for post-fire soil erosion (CSFS 2009). High-severity fires impact forest soils and hydrological integrity by removing the protective layer of leaves, branches, and needles which can lead to increased surface runoff and increased peak flows during heavy precipitation events (CSFS 2009). Increases in peak flows and erosion can mobilize large amounts of sediment and debris that can affect water quality and negatively impact hydrological infrastructure.

The UMC landscape contains nine 6th level watersheds (see Figure 2 below). Within the UMC landscape, the West Monument Creek and Upper Monument Creek watersheds are particularly critical as they are sources of municipal drinking water for Colorado Springs and Palmer Lake respectively. Colorado Springs Utilities has also established a pipeline supply network from the West Monument Creek watershed to feed the Rampart Reservoir in the southwest corner of the project area. This reservoir can provide up to 80 percent of Colorado Springs drinking water at any given time. The Waldo Canyon Fire burned a significant portion of the West Monument Creek watershed which has impaired the hydrological function of this landscape to some degree.

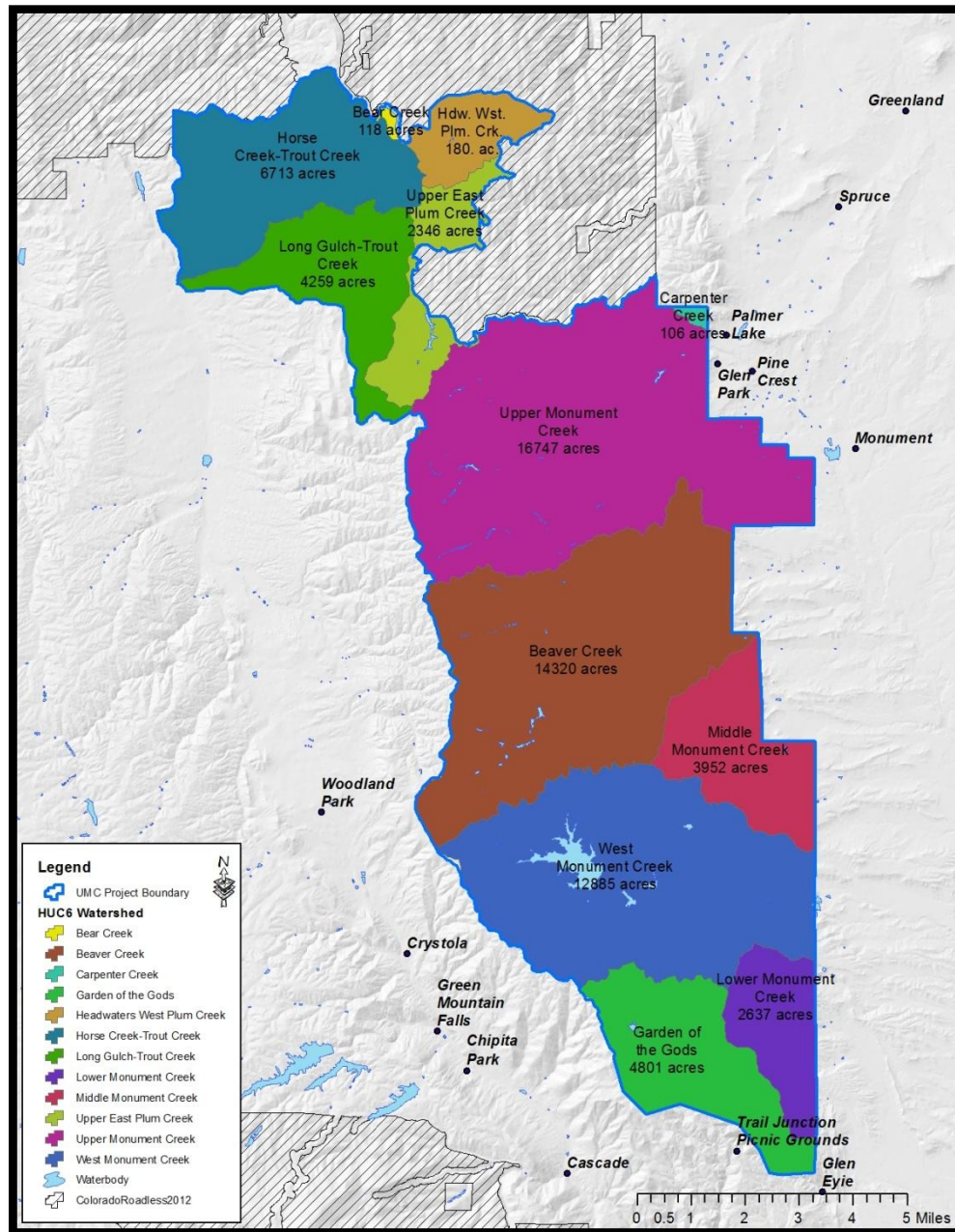


Figure 2. HUC6 watersheds within the UMC project area.

Disturbances

Fire

Fire is the dominant force that shapes and influences forested landscapes in the Rocky Mountains (Romme and Knight 1981, Peet 1988). Fire plays a critical role in shaping forest structure and composition by modifying overstory and understory distribution. Fire is also an important driver of ecosystem function, the effects from fire can modify/remove fuels, remove individuals or groups of overstory vegetation, prepare seed beds for regeneration, stimulate forage production, create snags, and facilitate nutrient cycling in soils (DeBano et al. 1998). However, fire can also

produce detrimental effects to forest ecosystems such as soil hydrophobicity, increased erosion, habitat destruction, carbon release, increased water temperatures and turbidity, and habitat destruction (DeBano et al. 1998). In more recent times fire has had significant impacts on human development, infrastructure, and water sources as the wildland urban interface continues to expand.

Fires can burn with a variety of intensities (low-to-high) and can produce a range of ecological effects (fire severity) on forested ecosystems (DeBano et. al 1998). Fires intensity (typically measured in flame length) is the amount of energy released which is directly correlated to the amount, arrangement, and condition of forest fuels. Fire severity is a measure of the negative effects that a fire has on forest vegetation, soils, water, wildlife habitat, human communities, etc (Tappeiner et al. 2007). The table below lists and describes typical historical fire severity classifications.

Table 1. Definitions of fire severity taken from Agee 1993.

Term	Definition of fire effects
High-severity fire	A fire that had high mortality of live, standing vegetation, > 80% of the existing basal area or overstory trees removed
Low-severity fire	A fire that had low to no mortality of live, standing vegetation, < 20% of the existing basal area or overstory trees removed
Mixed-severity fire	A fire that had effects that are intermediate, < 70% and > 20% of the existing basal area or overstory trees removed

Fire regimes are defined by the common fire type, intensity, severity, frequency, size and seasonality that naturally occur within a given region and forest type. Some important drivers of fire regimes are the accumulation of fuels, fuel type (fine to coarse woody), climate (dry vs. moist periods), and impacts to forest health (insect and pathogen damages) (Veblen and Donnegan 2005). Since forest types differ by species, structure, stocking, and site, the previously mentioned drivers will affect each forest type differently in both space and time. Historic fire regimes for forest cover types for the UMC project area are as follows:

Table 2. Characteristics of fire regimes for forest cover types found on the UMC landscape (adapted from Kaufmann et al. 2007, Veblen and Donnegan 2005, LANDFIRE).

Forest type	Interval (yrs), Fire type	Severity	Typical patch (ac)
Lower Montane (6,500 to 8,500ft) Ponderosa pine/Grass	2-15, Surface	Low	0.1-0.2
Mid and Upper Montane (8,500 to 9,500ft) Ponderosa Pine/Douglas-fir Woodland	10-45, Surface 150-300, Mixed	Low to Mixed	0.2-30
Mid and Upper Montane (8,500 to 9,500ft) Dry-Mesic/ Mixed Conifer Forest and Woodland	10-75, Mixed	Low to Mixed	3-100s
Mid and Upper Montane (8,500 to 9,500ft) Mesic Mixed Conifer Forest and Woodland	6-60, Mixed 100+, Crown	Mixed to High	3-100s
Subalpine (9,500-11,500ft) Lodgepole pine	100-400+, Crown	High	100s-1000s

Both human and lightning caused fires have been common on the Front Range landscape for centuries (Vale 2002). Prior to large scale permanent settlement, circa 1860, fires were predominantly lightning caused except around areas of high indigenous use where fire frequency was typically higher (Vale 2002). Fire frequency began to gradually change as settlement increased, but the most dramatic change came in 1910 when large fires in the Pacific Northwest and Inland Empire spawned the beginning of large-scale fire suppression across the nation (Pyne 2001). From 1910 to current times suppression of both lightning and human caused fires has

been the central focus on National Forest lands, which has effectively modified the fire regime in many areas. The UMC project area is a reflection of this suppression effort as only two fires have influenced the structure and development of the landscape. Had pre-settlement fire regimes occurred on the UMC landscape in the post-settlement era the project area there would be more occurrence and evidence of fire on the landscape.

Snow

Snow can disturb forest vegetation in a variety of ways. Deep snows that persist late into the growing season can limit plant regeneration (Butler et al. 1992). Delayed spring snowmelt may also favor the development of blackfoot snowmold which can limit the success of coniferous tree species (Knight 1994). Heavy snowstorms can cause breakage in limbs and tops of large conifer and can also cause groups of dense young conifers or aspen to collapse under weight stress (Veblen and Donnegan 2005).

Avalanches can be import localized disturbances in steep slopes and at higher elevations. Movement of snow in slide paths can damage and/or remove existing vegetation, and at times perpetuate the presence of shrubs (Knight 1994). Infrequent avalanches that can extend the typical terminus zone can damage areas unaccustomed to these disturbances, and would favor the regeneration of aspen if found previously on site (Veblen and Donnegan 2005).

There are no major avalanche slide paths within the UMC landscape. It is likely that small areas of snow sliding and sloughing occur throughout the project area, especially on steeper slopes and northern aspects. The effects of these slides to forest vegetation are likely minimal and highly localized. Minor amounts of snow breakage and collapse are like distributed throughout the project area as well, but are likely small and highly localized.

Floods

Spring flooding can result from the melting of snow pack at higher elevations. In a year of near-normal snow accumulations and normal spring temperatures, river stages typically increase but there is generally no flooding (Doesken et al. 2003). In above average snow years, or when there is widespread lower elevation snow accumulation and a sudden warming in the spring, there may be extensive flooding (Doesken et al. 2003). The greatest threat of flooding in Colorado is not snowmelt, most damages a product of flash flooding from localized intense thunderstorms. The most flash-flood prone regions of Colorado are found along the base of the lower foothills east of the mountains and typically mostly affects riparian vegetation (Doesken et al. 2003).

Changes and/or removal of forest vegetation has been implicated in increased stream damage after fire (Veblen and Donnegan 2005). When vegetation is mostly or completely removed by high-severity wildfire the corresponding decrease in interception, transpiration, and increase in rain-splash erosion can increase initial runoff (Wagenbrenner et al. 2006). Additionally, water-repellant layers within the soil profile generated from wildfire can also increase runoff (Imeson et al. 1992). Changes in the runoff can increase the rate and volume of runoff, which in turn not only increases the risk of flooding, but also the risk to property and life downstream (Robichaud et al. 2000). These effects can last for years until forest vegetation can become successfully reestablished on these sites.

Flooding from the Waldo Fire has been and is still occurring in parts of the watershed downstream from the burn scar. The effects of this flooding are currently found along the southwest corner of the project area. There is evidence of erosion and channelization for increased flow in many of the watersheds in this area. Vegetation is beginning to become

established in drainages, on favorable microsites, and within close proximity to remnant islands of unburned vegetation. Increased surface runoff and erosion will continue to decrease as more vegetation becomes established and as more erosion prevention measures are put in place during the Waldo Fire rehabilitation effort.

Forest Vegetation

Forest vegetation within the UMC project area is a diverse mosaic of forest structures and cover types driven by topographic, moisture, and elevational gradients. These vegetative patterns can be classified into recognizable ecological systems that aid in describing landscape vegetation patterns. Ecological systems represent recurring groups of biological communities that are found in similar physical environments and are influenced by similar ecological process (Comer et al. 2003). The low lying dry foothills along the eastern edges of the project area contain a mix of gamble oak-mixed montane shrublands and pinyon-juniper woodlands. As you move west and higher in elevation the project area is comprised of a mix of montane forest vegetation, but is mainly comprised (85% of the project area) of three predominant ecological systems: Ponderosa pine-Douglas-fir Woodland, Dry-mesic Montane Mixed Conifer Forest and Woodland, and Mesic Montane Mixed Conifer Forest and Woodland. The main ridge of the Rampart Range contains a small portion of a larger ecological system of lodgepole pine that continues north outside of the project area. Approximately 38 percent of the larger lodgepole pine ecological system is contained within the UMC project area boundary. Montane Riparian Systems and Montane-Subalpine Grasslands are interspersed throughout the project and can be found on a range of physical environments. A comprehensive breakdown of all ecological systems within the UMC landscape is provided in Table 3 below. Figure 3 following the table is a graphic representation of the Ecological Systems and their distribution within the UMC project area.

Table 3. Primary Ecological Systems of the Upper Monument Creek project area.

Ecological System	Acres	% of total area
Ponderosa Pine/Douglas-fir Woodland	17,337	32%
Dry-Mesic Montane Mixed Conifer Forest and Woodland	15,426	29%
Mesic Montane Mixed Conifer Forest and Woodland	13,003	24%
Montane Riparian Systems	5,841	11%
Lodgepole Pine Forest	3,512	4%
Gamble Oak-Mixed Montane Shrubland	1,710	3%
Montane-Subalpine Grassland	1,605	3%
Pinyon-Juniper Woodland	67	< 1%

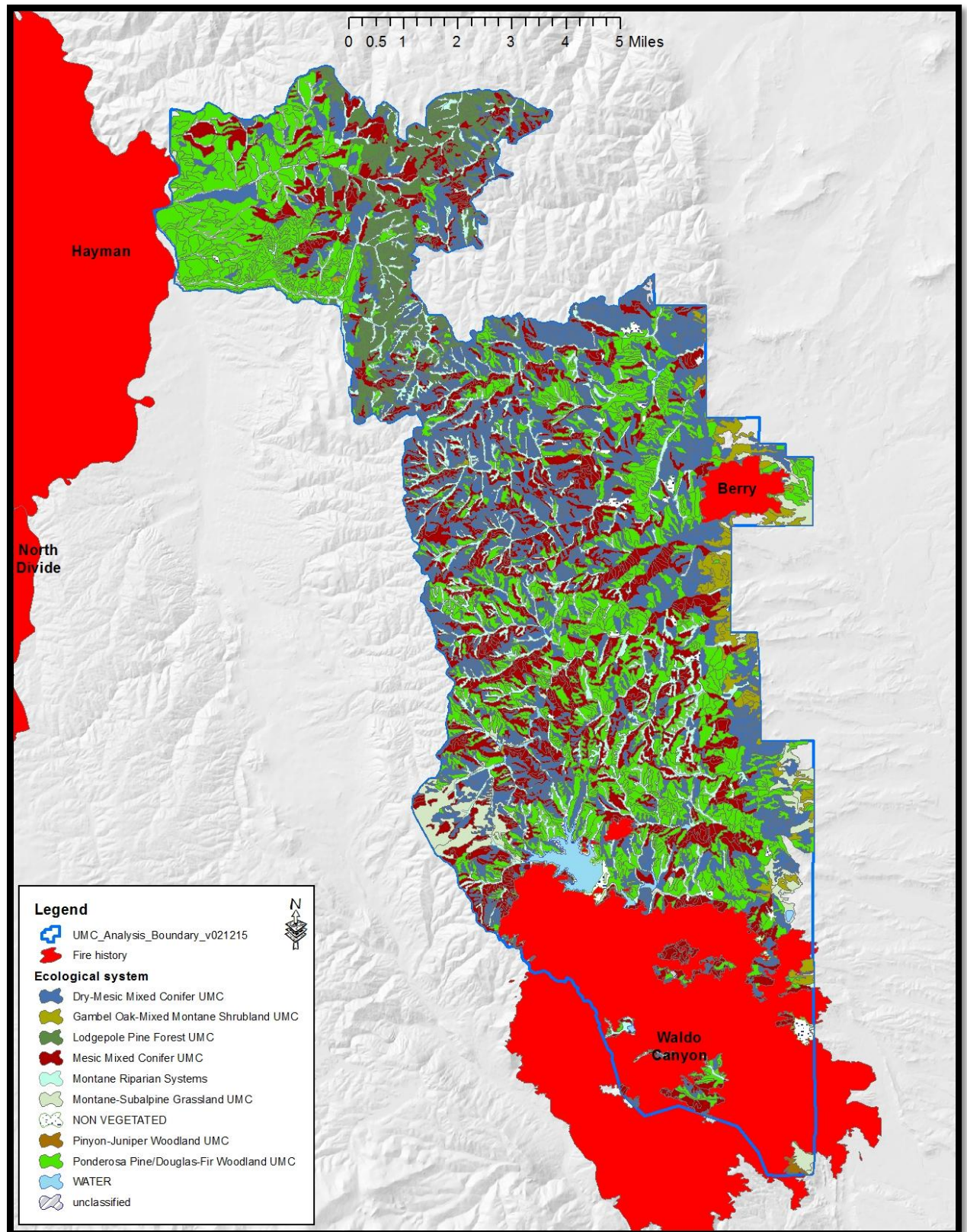


Figure 3. The ecological system distribution for the UMC project area.

Forest Ecological Systems have a variety of defining characteristics such as vegetation type, age, development stage, structure, and distribution. These characteristics form a complex web of interactions that define forested landscapes and lead to a shifting mosaic of forested conditions over time and space. In order to better understand the potential historic distribution and development of forest vegetation on the UMC landscape model simulations were run using the Vegetation Dynamics Development Tool (VDDT). These VDDT runs were compiled to generate and establish a natural range of variation (NRV) for each vegetation class for the Ecological Systems within the UMC project area. NRV was measured by vegetation type at the project area boundary scale (67,000 acres, encompassing nine 6th level watersheds). The following tables describe the three predominant Forest Ecological Systems in more depth to provide a better understanding of the existing conditions within the UMC landscape.

Ponderosa pine/Douglas-fir Woodland

The lower montane zone is dominated by ponderosa pine (historically < 30% canopy cover below 6600 feet), and more dense stands of Douglas-fir on north-facing slopes with occasional large Douglas-fir on other aspects. In the upper montane zone the ponderosa pine cover type occurs both as relatively pure stands and with significant components of Douglas-fir. There is typically a striking contrast in stand density and species composition on south- as opposed to north-facing slopes. Douglas-fir is prominent on north-facing slopes. Structural changes will vary greatly depending on disturbance history. Limber pine occurs in higher elevations in groups and as scattered individuals. Understory species can include Gambel oak, mountain mahogany, Arizona rescue, mountain muhly, kinnikinnick, and yucca. Surface, mixed, and stand replacing fire types are part of the historic fire regime.

Table 4. Ponderosa pine/Douglas-fir woodland ecological system distribution and characteristics.

NRV (%)	Vegetation Class	Description	Canopy cover (%)	Height (ft) DBH (in)
10	Early	Openings with up to 10% remnant overstory trees dominated by ponderosa pine and sometimes Douglas-fir. Some persistent openings.	0-70	0-15 < 5
10	Mid-Closed	Greater than 40% canopy closure, often in small patches with some persistent openings. Uneven aged structure developing.	41-70	15-50 5-16
15	Mid-open	< 40% canopy cover. Mosaic composition with pockets of regeneration, shrubs, grass, and openings. Uneven aged structure developing.	10-40	15-50 5-16
45	Late-open	< 40% canopy cover. Mosaic composition with pockets of	10-40	50-80

		regeneration, shrubs, grass, and openings. Uneven aged structure developing.		17-30
20	Late-closed	>40% canopy cover. Mosaic composition with pockets of regeneration, shrubs, grass, and openings. Old trees likely present Uneven aged structure dominates.	41-70	50-80 17-30

Table 5. Existing distribution of Ponderosa pine/Douglas-fir woodland vegetation classes compared to the natural range of variation.

Class	Early	Mid Closed	Mid Open	Late Open	Late Closed	Total
Acres	387	8,124	3,810	1,897	3,119	17,337
NRV %	10	10	15	45	20	100
Current % in class	2	47	22	11	18	100

Dry-Mesic Mixed Conifer Forest and Woodland

The composition and structure of the overstory varies based on the temperatures and moisture relationships of the site. Ponderosa pine, Douglas-fir, limber pine, and aspen make up the warm/dry mixed conifer. Gambel oak is often the dominant shrub in lower elevations. Ponderosa pine regeneration typically occurs after fire. Limber pine regeneration happens continuously between fires. Douglas-fir regeneration can happen in between and after fires. Douglas-fir can be a canopy dominant with ponderosa pine. Generally found between 6900-9500 feet, it can be found at higher elevations on south-facing slopes than north-facing slopes. This type has a variable distribution on east and west aspects. Surface, mixed, and stand replacing fire types are part of the historic fire regime.

Table 6. Dry-mesic mixed conifer forest and woodland ecological system distribution and characteristics.

NRV (%)	Vegetation Class	Description	Canopy cover (%)	Height (ft) DBH (in)
10	Early	Succession after lethal fire will depend on prior vegetation. In general conifer dominated, with some	n/a	0-15 < 5

		remnant ponderosa pine. Fire favors ponderosa pine regeneration. Gambel oak will resprout if available. If aspen cover is 50% or greater prior to disturbance, stand will regenerate to aspen.		
5	Mid-Closed	If aspen is dominant the stand will achieve a mid-closed stage. Conifers such as limber pine and Douglas-fir could be regenerating with it. Any surviving conifers would be canopy dominants.	41-80	15-65 5-16
20	Mid-open	Ponderosa is the canopy dominant with an understory dominated by Douglas-fir. Limber pine is present and some is entering main canopy. If aspen is present self-thinning would lead to an open canopy. Conifer needle cast creates a litter layer that could carry fire. Any fire would further open the stand by thinning aspen and fir.	11-40	15-65 5-16
40	Late-open	Ponderosa pine is the canopy dominant. Douglas-fir can also be a canopy dominant. If aspen is present its number are few. Low levels of suckering may keep it in the stand. Open aspen stands are not common in this class in warm/cry mixed conifer.	11-40	66-100 17-30
25	Late-closed	Conifer stand with minor aspen component. Mature to over-mature with heavy understory of conifers. Mainly composed of ponderosa pine, Douglas-fir, and limber pine.	41-80	66-100 17-30

Table 7. Existing distribution of dry-mesic mixed conifer forest and woodland vegetation classes compared to the natural range of variation.

Class	Early	Mid Closed	Mid Open	Late Open	Late Closed	Total
Acres	648	7,923	4,073	1,326	1,456	15,426
NRV %	10	5	20	40	25	100
Current % in class	4	51	27	9	9	100

Mesic Montane Mixed Conifer Forest and Woodland

The mixed conifer is driven by elevation and aspect. The cool moist mixed conifer will have much less ponderosa pine than the warm/dry. However, ponderosa pine is found in small groups or isolated patches usually in open areas, on meadow edges, and ridges. Douglas-fir and spruce are often canopy dominants with aspen present in most stands. The other major tree species found in the cool/moist are limber pine, Engelmann spruce, and white fir can be quite common. Lodgepole pine is uncommon but can be found. This type is found on northerly aspects, generally on steep slopes, and from 7500 to 9500 feet in elevation. Surface, mixed, and stand replacing fire types are part of the historic fire regime.

Table 8. Mesic montane mixed conifer forest and woodland ecological system distribution and characteristics.

NRV (%)	Vegetation Class	Description	Canopy cover (%)	Age (years)	Height (ft) DBH (in)
10	Early	Succession after lethal fire will depend on prior vegetation. Aspen may or may not be present and depends on pre-disturbance population. The site will start as grass/forb/shrub and aspen if present. Fire can prolong this stage. Remnant conifers may be present and can be a seed source.	0-100	0-39	0-15 < 5
25	Mid-Closed	If present aspen will be dense and over 10 feet in height. Seedling-to-medium sized conifers can be found mixed with aspen. Understory may include mountain snowberry, common juniper, wild rose,	41-80	40-149	15-50 5-16

		grasses, and forbs.			
20	Mid-open	If present aspen will be dense and over 10 feet in height. Seedling-to-medium sized conifers can be found mixed with aspen. Understory may include mountain snowberry, common juniper, wild rose, grasses, and forbs. Overall stocking is low.	10-40	40-149	15-50 5-16
15	Late-open	Aspen will be rare and in subordinate canopy positions if found. Understory is diverse mix of grasses, forbs, and shrubs. Conifer stocking is scattered and low.	10-40	150-190	50-80 17-30
30	Late-closed	Dense conifer stand. Blue spruce and Engelmann spruce can be found. Aspen present but in small numbers. Dead and down wood proliferate. Understory is likely to be depauperate.	41-100	150+	50-80 17-30

Table 9. Existing distribution of Mesic mixed conifer forest and woodland vegetation classes compared to the natural range of variation.

Class	Early	Mid Closed	Mid Open	Late Open	Late Closed	Total
Acres	155	9,232	631	299	2,686	13,003
NRV %	10	25	20	15	30	100
Current % in class	1	71	4	3	21	100

Lodgepole Pine Forest

Rocky mountain lodgepole pine forests are typically found in upper montane and subalpine elevations and are typically above 9000 feet. Lodgepole pine is generally persistent, although aspen may be seral to it in areas. Understory vegetation can vary from sparse shrub cover, to grass, to barren. The fire regime for these forest types is typically high severity and can burned in mixed to stand replacement patterns.

Table 10. Lodgepole pine forest ecological system distribution and characteristics.

NRV (%)	Vegetation Class	Description	Canopy cover (%)	Age (years)	Height (ft) DBH (in)
20	Early	Grasses, forbs, low shrubs and lodgepole seedlings and saplings; aspen maybe present. Even-aged, canopy closure will tend to exceed 30-40% after seedlings area established at moderate to high densities and are well distributed. The majority of the trees are small sapling size, > 1.0" dbh.	0-80	0-39	0-33 < 5
20	Mid-Closed	Moderate to dense pole-sized trees, sometimes very dense (dog-hair); aspen usually not present. Even-aged.	61-100	40-159	33-66 5-9
20	Mid-open	If present aspen will be dense and over 10 feet in height. Seedling-to-medium sized conifers can be found mixed with aspen. Understory may include mountain snowberry, common juniper, wild rose, grasses, and forbs. Overall stocking is low.	10-40	40-149	15-50 5-16
15	Late-open	Aspen will be rare and in subordinate canopy positions if found. Understory is diverse mix of grasses, forbs, and shrubs. Conifer stocking is scattered and low.	10-40	150-190	50-80 17-30
30	Late-closed	Dense conifer stand. Blue spruce and Engelmann spruce can be found. Aspen present but in small numbers. Dead and down wood proliferate. Understory is likely to be depauperate.	41-100	150+	50-80 17-30

Table 11. Existing distribution of lodgepole pine forest vegetation classes compared to the natural range of variation.

Class	Early	Mid Closed	Mid Open	Late Open	Late Closed	Total
Acres	76	871	662	543	1,360	3,512
NRV %	20	20	20	15	30	100
Current % in class	2	25	19	15	39	100

The data provided above indicate that changes in land use patterns and effective fire suppression over the last 100+ years have modified ecological systems within the UMC landscape. Current vegetative conditions within the UMC landscape differ, in both structure and distribution, from historic forest conditions, which is common place throughout the Front Range (Agee 1993). The Mid-closed vegetation class dominates the UMC landscape and is significantly higher than NRV distributions in all three of the dominant ecological systems. Summary data also indicate that late vegetation classes (open and closed) are found in far smaller quantities within the UMC project area when compared to NRV estimations. The Early vegetation class for all three dominant ecological systems is the only class that currently found in distributionssimilar to historical conditions.

Studies from researchers such as Dr. Merrill Kaufmann and others (Brown et al. 1999, Kaufmann et al. 1999, Kaufmann et al. 2000, Kaufmann et al. 2001, Dickinson 2014) indicate that the historic forest was older, more open, and more structurally diverse than today's conditions. Openings of a variety of sizes were commonly found across the landscape and were highly dependent on fire to create and maintain these breaks in the canopy (Brown et al. 1999, Kaufmann et al. 2001, Dickinson 2014). Large openings with few or no conifers were persistent across a greater percentage of the Front Range landscape (Kaufmann et al. 2000). More recent research also shows smaller and less persistent canopy gaps at the stand level are also significantly lower than historic conditions (Dickinson 2014). The data provided for each of the three dominant ecological systems of the UMC verify that typically denser and contain fewer openings than occurred historically.

In order to better understand the differences between existing and historical forest conditions an analysis was run using the ecological departure metric developed by the LANDFIRE program and an additional metric of open forest canopy departure (Low 2013). Ecological departure incorporates species composition, vegetation structure, and disturbance regimes to estimate an ecological systems' departure from its natural range of variability (Low 2013). Ecological departure from NRV and open forest canopy departure and are measured on a scale of 0 to 100, where higher numbers indicate a greater departure (Low 2013). An additional metric of open forest departure was developed and applied because the ecological departure metric did not sufficiently address the changes in achieving an open canopy condition (Low 2013). The open forest departure metric isolates the degree of canopy closure as compares to the more open historical conditions (Low 2013). Key findings from these evaluations indicate that the three dominant Ecological Systems within the UMC landscape are all moderately departed from their natural historic conditions and there is currently approximately twice as much forest in a closed

canopy condition than occurred historically (Low 2103). This translates into a shortage of approximately 15,000 acres in the open canopy forest conditions (Low 2013).

Table 12. Summary of ecological system departure for the UMC landscape.

Ponderosa pine/Douglas-fir Woodland		Dry-Mesic Montane Mixed Conifer Forest		Mesic Montane Mixed Conifer Forest	
Ecological Departure	Open Forest Departure	Ecological Departure	Open Forest Departure	Ecological Departure	Open Forest Departure
40	43	52	43	42	57

These findings affirm that forest vegetation conditions within the UMC project have indeed shifted from historic conditions that are similar to those found and described by researchers throughout Front Range and greater Rocky Mountain region.

The structure and distribution of forest vegetation across a landscape can have profound impacts on forested environments. Of particular concern in the UMC landscape is the complex interaction between fire and forest vegetation. The majority of the Ecological Systems within the UMC project area historically and currently burn under mixed severity conditions that are highly dependent on climatological cycles (Rocca et al. 2014, Sherriff et al. 2014, Williams and Baker 2012, Veblen and Donnegan 2005, Huckaby et al. 2001, Brown et al. 1999). For instance, lower montane forests experienced more frequent low severity surface fires but also have a component of passive crown fires (Rocca et al. 2014, Sherriff and Veblen 2008, Brown et al. 1999). Upper montane forests typically experienced a gradient of surface fires at lower elevations and in drier aspects to a mix of surface fire, patchy crown fire, and large areas of active crown fire as moisture and elevation increase (Rocca et al. 2014). Fires in subalpine and lodgepole pine (on drier sites) forests were typically rare and would burn with high severity over hundreds to thousands of acres (Sibold et al. 2006, Shoennagel et al. 2005).

Fire regimes of the majority forest ecological systems within the UMC landscape have undergone changes that correspond to changes in forest vegetation and structure attributed to fire exclusion (Huckaby et al. 2001, Brown et al. 1999, Agee 1993). Currently many montane forests have greatly increased tree densities that have altered fuel load and structure, two factors that greatly influence fire regimes and have the potential to shift conditions outside of the NRV (Agee 1993). There is also concern that changes in climate have the potential to confound existing concerns with the role of fire, or lack thereof, on forested landscapes (Rocca et al. 2014).

The existing condition of forest vegetation within the UMC landscape has changed substantially over last 100 years. Old trees and stands are rare features within the landscape and are unevenly distributed throughout the project area. When comparing the existing forest structure and density to conditions prior to large scale settlement there has been a clear loss of openings (both large and small) within the forest canopy and a corresponding increase of tree stocking within most of the stands within the project area. The dense forest conditions that characterize the landscape today have increased levels of competition which reduce tree vigor, are more prone to insect outbreaks, and are capable of carrying large active crown fires in all forest ecological systems. Large crown fires within the UMC project area could have profound negative effects on forest vegetation, wildlife habitat, soils, infrastructure, personal property, and municipal watersheds.

Forest Health

Most forest insects and diseases are native to and important players in Rocky Mountain forest ecosystems (Allen et al. 2010). Some impacts on forest ecosystems include reduced tree growth, tree mortality, reductions in timber productivity, changes in wildlife habitat, modifying fuel conditions and amounts, reductions in scenic quality, and changes to water quality (Allen et al. 2010). Insects and diseases can also greatly impact forest age distributions, structure, species composition, and density. In terms of mortality and growth loss, the impacts of insects and disease are far greater than any other forest disturbance, including fire (Allen et al. 2010). In the majority of forest ecosystems, native insect and disease populations occur at endemic levels. However, when conditions are favorable outbreaks can be severe and large scale. Changes in forest density and structure as well as climatic conditions can trigger such outbreaks.

The following section describes the current forest health conditions within the UMC project area.

Western spruce budworm

Western spruce budworm (*Choristoneuraoccidentalis*) is a common defoliator in western forests. Female western spruce moths typically lay their eggs on needles in mid and upper crowns of dominant and co-dominant host trees. Host trees in the area are predominantly Douglas-fir, although the insect will also feed on true firs and spruces. Eggs will hatch in late summer with larvae seeking overwintering sites to commence feeding on the host the following spring. The larvae will first mine into buds and then feed on new needle growth into early summer (Cain 2014). Defoliation typically occurs at tree tops and outer branches, but can occur lower and further in the crown when infestations are heavy (Allen et al. 2010).

Budworm larvae have a tendency to drop from branch to branch on long silk threads when disturbed. If host trees are dense and multi-storied, budworm survival is enhanced and intermediate, suppressed or healthy young understory trees may be killed by heavy defoliation caused by dispersing larvae. Dominant and co-dominant trees are also heavily defoliated but these stronger trees are generally able to withstand budworm defoliation. Trees with heavy defoliation or several years of defoliation may show reduced radial growth and/or top killing. Douglas-fir beetle and Douglas-fir pole beetles may also cause mortality in trees stressed by western spruce budworm feeding (Cain 2014).

The UMC landscape is currently experiencing a range of western spruce budworm defoliation. Data from the Forest Health and Protection aerial surveys indicate that the largest areas of defoliation within the project area were initially detected in 2009 when approximately 31,000 acres were identified as having high levels of defoliation (i.e. greater than 50% defoliation). The 2009 defoliation is mainly comprised of fairly large and contiguous drainages ranging in size from 3,000 to 10,000 acres, but also contains smaller localized pockets of budworm defoliation. Subsequent surveys in 2010 and 2011 identified additional areas affected by budworm defoliation but the expansion was relatively minor totaling only about 1,200 acres between the two years. It seems that the severity rather than extent of budworm defoliation has increased since 2009 as currently many areas, especially Upper Monument Creek watershed, are experiencing severe defoliation (see Figure 4 below). In some of these stands defoliation is causing high (70-80%) level of mortality and is especially prevalent in areas with high stocking of intermediate and overtopped Douglas-fir with overlapping crowns. The scattered localized areas of budworm activity typically have lower levels of defoliation when compared to the larger epicenters and are more indicative of endemic levels of defoliation where mortality is not expected to occur or will occur in limited amounts.



Figure 4. Typical example of moderate-to-severe western spruce budworm defoliation within the UMC project area.

Bark Beetles

Members of the genus *Dendroctonus* are by far the most destructive group of bark beetles in North America. Twelve species occur in the West (Furniss and Carolin 1977), but only the mountain pinebeetle (*Dendroctonus ponderosae*), the spruce beetle (*Dendroctonus rufipennis*) and the Douglas-fir beetle (*Dendroctonus pseudotsugae*) are likely to have a significant effect on the conifers within the UMC landscape.

Mountain pine beetle (MPB) attacks and kills lodgepole, ponderosa, sugar, and western white pines. Outbreaks frequently develop in dense stands of pole-sized ponderosa pine. When outbreaks are extensive, millions of trees may be killed each year, influencing the forest ecosystem (McCambridge et al. 1979). For example, the MPB kills proportionately more large-diameter trees than small-diameter trees and thus alters the diameter distribution (Schmid and Amman 1992). In general lodgepole pine stands that are over 80 years in age, have average diameters greater than 8 inches and are at lower elevations have a higher risk rating. For ponderosa pine, high risk stands have a high stand basal area (high density) and an average diameter at breast height of 10 inches or greater (Chojnacky et al. 2000).

Mountain pine beetles primarily attack lodgepole and ponderosa pines. However, limber pine and bristlecone pine may also become infested and killed. Outbreaks of this insect frequently develop in lodgepole pine stands that contain large diameter trees or in dense pole-sized ponderosa pine. When outbreaks are extensive, large areas of forest may be killed and beetles may attack smaller and smaller trees as well as less desirable tree species. However, under high beetle populations even low risk stands may become infested. Aerial surveys have identified only minimal MPB activity with the UMC landscape, totaling only 30 acres. Areas of MPB mortality are scattered throughout the project area and predominantly small in extent (typically 0.1 acres), but range up

to 11 acres. Regionally mountain pine beetle outbreaks have ended or decreased as the supply of available hosts has declined dramatically from epidemic level mortality in recent years.

Spruce beetle predominantly attack Engelmann spruce and blue spruce, but can also infest lodgepole pine during large outbreaks when preferred hosts are limited in areas. The spruce beetle is the most significant mortality agent of mature spruce (USDA FS 2010b). Outbreaks can cause extensive tree mortality and can alter stand composition and structure. Since mature and over-mature spruce are preferred hosts, average tree diameter, tree height, and stand density are all reduce following large outbreaks (USDA FS 2010b).

Spruce beetles prefer down spruce to standing trees, so areas with recent windthrow can be catalysts for spruce beetle outbreaks. Typically stands most susceptible to attack are located along drainage bottoms in stands where basal areas are 150 ft² per acre and greater, and where average diameters at breast height are 16 inches or greater (USDA FS 2010b). When outbreaks reach epidemic proportions large scale landscape level mortality is realistic and virtually impossible to stop with management activities.

Aerial surveys from 2014 indicate that the current spruce beetle epidemic is expanding rapidly in Colorado, and the state's southern forests are experiencing the largest as fastest growth. In 2014 and additional 253,000 acres of new spruce beetle infestations were detected (USDA FS 2010b). Aerial surveys indicate that the Pike National Forest and the UMC project currently have no detectable or epidemic level spruce beetle outbreaks. However, current trends indicate that most recent spruce beetle outbreaks populations are getting closer to the UMC landscape and it is likely that increased beetle outbreaks could occur within the next few years.

The Douglas-fir beetle is similar to other *Dendroctonus* bark beetles and typically attacks larger, dominant trees (Veblen and Donnegan 2005). Populations can reach epidemic proportions when forests are stressed from overstocking, from drought, fire, or following outbreaks of Douglas-fir tussock moth. Western spruce budworm defoliation may also increase Douglas-fir susceptibility to attack, and Douglas-fir beetle epidemics appear to have arisen during and expanded following outbreaks of western spruce budworm (Hadley and Veblen 1993, Schmid and Mata 1996). Residual trees in and along fires perimeters are also likely hosts for the Douglas-fir beetle as they are near potential source populations and commonly have damages and reduced vigor from fire effects. Forest Health aerial surveys over the last five years have identified small endemic levels of Douglas-fir beetle activity in the northwestern portions of the project area, totaling only about 330 acres. Most of pockets of mortality are small, typically less than 15 acres, and are typically affecting anywhere from 1 to 20 trees per acre.

Douglas-fir Tussock Moth

Douglas-Fir tussock moth (*Orgyia pseudotsugata*) is defoliator and feeds upon tree foliage. Outbreaks develop explosively and after about 3 years, abruptly subside. Douglas-fir tussock moths along the Front Range are typically not as widespread as western spruce budworm but the damage and mortality across all host size classes tends to be more severe in a more localized area or limited to individual drainages. Between outbreaks, this insect is seldom seen (Furniss and Carolin 1977).

Studies of large Douglas-fir tussock moth (DFTM) outbreaks in the Northwestern United States have indicated that the underlying cause of a DFTM outbreak is a susceptible forest. A susceptible forest is characterized by dense, uneven-aged and multi-storied stands, of predominately Douglas-fir and/or true firs. Many years of forest management that emphasized

fire prevention and suppression, along with other management practices, have resulted in a gradual shift from ponderosa pine to Douglas-fir. This change in forest composition and structure has resulted in large areas along the Front Range of Colorado that are more susceptible to large scale DFTM outbreaks.

In 1983, a major outbreak of DFTM occurred in the South Platte watershed on the Pike National Forest that lasted through the end of the decade (Veblen and Donnegan 2005). The outbreak defoliated 7,000 acres of Douglas-fir scattered over a 19,000-acre area, resulting in significant mortality. This was one of the largest outbreaks of DFTM ever recorded in the state of Colorado.

Douglas-fir tussock moth was not seen at with the UMC project area on a recent field visit by entomologists, but it is active further south on Cheyenne Mountain and trap catches in 2013 along Rampart Range Road were elevated in 2013 (Cain 2014). Defoliation from Douglas-fir tussock moth in this area is likely at endemic levels but the potential for future epidemic cannot be ruled out as a potential species of concern as evidence from the surrounding landscape indicates.

Dwarf Mistletoe

Dwarf mistletoe (*Arceuthobiumvaginatum*) is a parasite that affects ponderosa pine throughout the UMC project area. Mistletoe infections weaken trees and make them more susceptible to attack by other pathogens, such as mountain pine beetle (Frye and Landis 1975). Dwarf mistletoe causes swelling in pine branches, which ultimately reduces a tree's growth rate in both height and diameter once the upper half of the tree's crown is infected. Severe infection eventually kills the tree. The time required for the parasite to kill a tree varies considerably and depends on many factors.

At large scales, trends in mistletoe infection are uncertain. The montane zone is characterized by a variable severity fire regime and heterogeneity of stand ages, it is likely that infection has probably been continuously high over the past several centuries (Veblen and Donnegan 2005). The increase of stand replacing fires in recent time may temporarily reduce infection rates in the young post-fire stands (Veblen and Donnegan 2005). However if infected overstory trees survive a fire they can serve as a source for subsequent infections in regenerating stands. Alexander and Hawksworth (1975) suggest that dwarf mistletoe abundance has increased throughout the Western U.S., as well as the severity of infection.

Climate change

Carbon dioxide has been identified as a central driver of changing climatic characteristics and is in constant flux due to the global carbon cycle (Solomon et al. 2007). Carbon dioxide emissions from the global carbon cycle are now coupled with increasing rates of anthropogenic induced CO₂ releases, and current trends indicate that these levels show no indication of slowing (Solomon et al. 2007). Forests on the Front Range not only provide valuable ecosystem services such as erosion control, wildlife habitat, and water recharge, but forests also drive terrestrial carbon budgets through storing carbon in live biomass, forest soils, and dead woody material (Malmsheimer et al. 2008).

Future projections indicate that northern latitudes are expected to warm due to changes in climate, and this warming will likely be accompanied by changes to abiotic conditions, disturbance patterns, and biotic cycles (Malmsheimer 2008). Current projections indicate that temperatures will increase over the next several decades and all seasons are expected to see an average increase of 3°C (Liu et al. 2013). Temperature changes can expand the potential range of tree species, extend the growing season, modify the timing of budbreak and dormancy, and increase or

decrease biomass accumulation depending on local conditions (Malmsheimer 2008). Many of the potential benefits from a changing climate for forested vegetation will be affected by limiting factors such as available soil moisture. Changes in moisture patterns have the potential to increase the potential for water deficit during the growing season lowering both live and dead fuel moisture contents as precipitation amounts decrease (Rocca et al. 2014). Rises in temperature will increase the transpiration demand for forest vegetation which combined with lower precipitation amounts has the further potential to stress live trees, predispose trees to forest insects and disease, reduce biomass accumulation, and reduce fuel moisture.

Fire activity and characteristics are also projected to be affected by changes in climate. Under a projected doubling of carbon dioxide levels Price and Rind (1994) have suggested that there will possibly be a 44% increase in lightning caused fires which will also correlate to an increase of forested area burned by 78%. Fire intensity and severity, along with area burned, are all predicted to increase within the western United States under modeled climate change scenarios (Flannigan et al. 2000). Warmer spring temperatures will result in earlier snow melt and warmer summers and falls will also likely lead to drier forest fuels as they are exposed to warmer drier conditions for a greater portion of the year and will extend the fire season (Rocca et al. 2014, Lui et al. 2013). Climate driven changes in abiotic processes combined with dense existing forest conditions has the potential to increase fire occurrence, size, and severity although site specific predictions are difficult to predict (Rocca et al. 2014). Fire regimes within the UMC landscape are very dependent on climatological cycles and have been for centuries, therefore changes in climatic characteristics have the potential to significantly affect future fire characteristics within the project area.

Uncharacteristically dense forests that are found throughout the Rocky Mountains are highly likely to receive insect outbreaks from bark beetles, spruce budworms, and tussock moths especially under climate change scenarios (Covington et al. 1994, Savage et al. 1996, Skinner and Chang 1996, Breshears and Allen 2002, Oliver 2002, Schimel 2004, Peterson et al. 2005). Climate change induced droughts and changes in precipitation will likely create stands more susceptible to insects as these trees experience reduction in available soil moisture, reducing tree vigor, making them less capable of fending off infestations (Negron 1998). Increased stress in trees is only one factor to consider when looking at climate effects on forest insects. Multiple studies indicate that there is real potential for shifts and increases in habitat for pest species such as mountain pine beetle and the gypsy moth (Logan et al. 2003, Logan and Powell 2001). This expansion of potential habitat is fairly common as models indicate that the warmer northerly conditions will also likely increase the outbreaks of typically southern insect species into higher latitude and elevations and can expose once safe tree populations to additional sources of insect disturbance altering mortality events (Dale et al. 2001). There is also evidence that forest pests are capable of producing large and more brood per year with more favorable warming, thus increase the potential for larger more severe attacks annually (Mitton and Ferrenberg 2012). It is also likely that an increase in fuel loading and a change in fuel structure would be coincident with increases in insect induced mortality which could affect fire potential and behavior. These shifts in forest pest habitat can impact forest development dynamics by altering species composition and tree distribution and has the potential to create forest vegetation patterns with no historical analogy. Current endemic and epidemic forest insect populations within the UMC project area have the potential to increase under future projected climate scenarios and could substantially alter future forest conditions.

Although it is difficult to address and manage for all potential changes driven by a modified climate, active management of forest ecosystems can help alleviate and curtail some potential

effects. The USDA 2010-2015 Strategic Plan, specifically Goal 2, states that plan goals are to “ensure our national forests and private working lands are conserved, restored, and made more resilient to climate change, while enhancing our water resources” (USDA 2010). Creating healthy, resistant, and resilient forest conditions through silvicultural practices can aid in helping forests adapt to changing climatic conditions (Malmsheimer 2008). Managing forests through harvesting and thinning operations can result in conditions that are both ecologically favorable and can increase carbon sequestration (Sedjo et al. 1995). Vigorously growing stands are good candidates for absorbing the deleterious and positive effects of a changing climate as they are less influenced by stresses of competition for growing space. Rocca et al. (2014) propose that mechanical treatments and the use of prescribed fire to restore or maintain historical forest structure could be effective strategies in trying to mitigate the impacts of climate change. Other authors stress that increasing forest resistance (i.e. the capacity of an ecosystem to avoid or withstand a disturbance) and resilience (i.e. the capacity of an ecosystem to regain function and development after a disturbance) may be more important than mimicking historic conditions that developed under entirely different climatic conditions (Malmsheimer 2008). Regardless of treatment goals designing more fire-resistant stands and landscapes will create forests that are more resistant and resilient to the changes imposed on them by climate change (Stephens et al. 2012).

Desired Condition

Compliance with Forest Plan and Other Relevant Laws, Regulations, Policies and Plans

Management direction for the Upper Monument project is set forth in the Pike and San Isabel Land and Resource Management Plan (USDA FS 1984). This plan provides the framework to guide project planning as well as resource management operations of the Pike-San Isabel National Forests. The 1976 National Forest Management Act (NFMA) requires that site-specific project decisions must be consistent with the Forest Plan. Forest Plan goals and objectives guide the identification and selection of potential agency projects. The determination of whether or not an individual project is consistent with the Forest Plan is based on whether or not the project adheres to forest-wide and management area standards.

Management direction is expressed in terms of both Forest Direction and Management Area Direction. Forest Direction consists of goals, objectives and management requirements which are generally applicable to the entire Forest (USDA FS 1984). The management requirements contained in the Forest Direction section of the Forest Plan set the minimum conditions that must be maintained while moving toward a desired condition and meeting the specified goals and objectives (USDA FS 1984). Management Area Direction contains management requirements specific to individual areas within the Forest and are applied in addition to the Forest Direction Management Requirements (USDA FS 1984).

There are 8 designated Management Areas within the UMC project area, they are as follows:

Management Area	Description	Acres (Percent of project area)
2A	Focus on outdoor recreation in semiprimitive setting including year-round motorized and non-motorized	10,944 (16%)

	recreation.	
2B	Focus on outdoor recreation in a roaded natural and rural setting including year-round developed facilities and motorized and non-motorized recreation.	21,253 (32%)
4B	Provides wildlife habitat needs and permits dispersed non-motorized and motorized recreation.	7,116 (11%)
5B	Emphasizes the management of big game winter and summer range.	4,029 (6%)
7A	Emphasizes productive tree stand management on lands available, capable and suitable for production of a variety of commercial and noncommercial wood products.	3,934 (6%)
7D	Emphasizes productive tree stand management on lands available, capable and suitable for production of a variety of products other than sawtimber.	6,279 (9%)
10B	Provides for the management of existing or potential research areas.	4,407 (7%)
10E	Provides for municipal watershed and municipal water supply watersheds.	8,880 (13%)

Specific silvicultural prescriptions and standards and guidelines for each of the Management Areas are found in the Forest Plan Section III. Forest Plan goals that are relevant to the forest vegetation assessment include:

- Practice vegetation management to provide multiple benefits using a comprehensive timber management program as a tool (III-4).
- Provide for increased production and productive use of wood fiber while maintaining or improving other resource values (III-4).
- Improve age class and species distribution of tree stands forest-wide (III-4).

- Perpetuate the aspen type (III-4).
- Improve the health and vigor of all vegetation types (III-4).

Forest Vegetation

The desired condition for forest vegetation within the UMC project area is one where forest structure is varied across the landscape and is capable of being resilient to disturbances both within and outside of the natural range of variation. Treatments will strive to meet forest conditions (structure, species composition, distribution, fire regimes) similar to the NRV when applicable and feasible. But when social concerns for infrastructure, municipal watersheds, etc. are overarching goals using NRV as treatments as target conditions may not achieve the desired condition and treatments will be modified to meet the appropriate goals. More specific desired conditions for the UMC project area include:

- A landscape comprised of a range of structural and developmental conditions in all forest ecological systems.
- A reduction in mid-closed structural stages for the three predominant ecological systems: Ponderosa pine-Douglas-fir Woodland, Dry-mesic Montane Mixed Conifer Forest and Woodland, and Mesic Montane Mixed Conifer Forest and Woodland to encourage the development of more mid-open, late-open, and late-closed structural stages similar to the NRV distribution for these structures. Structural stages should include even-aged, uneven-aged, and multi-aged stand and group structures.
- Varying residual densities and basal areas among and within treatment areas based on topographic variation and site differences. For example, low-density structures are appropriate on ridgetops and south-facing slopes and could grade downslope into higher density areas.
- Enhance the characteristic “groupy” structure of dry forest types such as ponderosa pine and dry-mixed conifer when possible.
- A landscape where small and large openings in the forest canopy are more prevalent; using NRV as a guideline for size and distribution but making adjustments depending on site and goals. Openings should have highly variable shapes and arrangements and should expand upon existing openings to the extent possible.
- Increase the amount and distribution of early seral lodgepole pine across the native range.
- Forest conditions where fires are capable of burning with intensities, severities, and at scales within the NRV for specific ecological systems.
- Landscape heterogeneity that provides natural barriers to the spread of high-severity disturbance events over large scales.
- Create fuelbreaks in tactical locations throughout the project area in order to increase the likelihood of effective wildfire suppression and containment.
- Forest structures that minimize the potential of negative effects from fire and insects on municipal watersheds and infrastructure and that promote watershed health.

- Protect and/or encourage the maintenance and development of large (18+ inches in d.b.h.) old-trees, snags, and downed woody debris to add structural complexity where lacking.
- Enhance the aspen component of the landscape by expanding access to available growing space or through regeneration.
- Riparian swale areas that both contribute to overall watershed health and are less susceptible to high severity fire.
- Forest conditions where epidemic outbreaks of forest pests are minimized.

Environmental Consequences

Methodology

Feasibility Analysis

The bulk of this effects analysis was derived from corporate Forest Service geographical information system (GIS) data, but professional judgement and experience were also used. Treatment areas were identified by forest cover type and subsequently broken into subsets based on the type of implementation tool/s that could be realistically used in an area. Feasibility categories were established based on data from mechanical and manual work that has been accomplished on the Forest by contractors.

The feasibility breakdown is as follows:

Mechanical feasible – Slopes from 0-30%

Mechanical marginal – Slopes 30-40%

The category defined as “mechanically feasible” implies that for any forest type in this classification that whole tree skidding and/or mastication is possible in all or the majority of a stand. However, it is highly likely that there are areas within these forest types where slope steepness precludes the use of mechanical equipment and will therefore require adjustments on the ground during project layout. Typical types of equipment utilized in these areas will be track or rubber tire feller bunchers, track or rubber tire masticators, track or rubber tire grapple skidders, processors, stroke-delimbers, and loaders. However, there could be any number or variety of these types of equipment used in operations which will depend on availability and contractor capabilities.

The category defined as “mechanically marginal” indicates that within a forest vegetation type that the possibility of using mechanical equipment is highly unlikely but that there could be portions of a stand where the use of mechanical equipment is possible. These areas will typically be treated by manual methods such as hand work with chainsaws but there could also be tracked masticators and/or tracked chippers used in favorable areas. Activity fuels that are not masticated will typically be lopped and scattered or piled.

Forest stands where average slopes were greater than 40 percent were considered to only be capable of being treated by manual means, i.e. handcrews with chainsaws. Activity fuels in these areas will be lopped and scattered or piled. There are currently no areas with average slopes greater than 40 percent that are scheduled for treatment with the UMC project area.

Vegetation Class Redistribution

A central goal of this project is to modify and treat forest vegetation in order to achieve a distribution of forest development stages (vegetation classes) that more closely reflects the natural range of variation and to increase openness (interspatial and stand scale) within the project landscape. Management actions were assigned success rate, i.e. the rate at which treatment types are able to achieve desired open forest conditions, and are based upon professional judgement of Forest Service staff (Low unpublished).

A critical limiting factor in thinning treatment effectiveness for all montane forest types is that there are very few large trees within forest stands of all types across the landscape. This lack of large trees limits the ability mid-closed and mid-open vegetation classes to move into the late-open vegetation class. Thinning in the mid vegetation classes will increase interspatial openings, lower basal area, and increase the quadratic mean diameter, but without having abundant existing large trees within these treatment blocks it is very unlikely that these areas will move into the late-open vegetation class. This effect is most prominent in mid-closed vegetation class, as compared to the mid-open vegetation class, where competition for growing space is high and few trees are able to express dominance and out-grow the surrounding tree vegetation. This high level of competition combined with the low site indices that are characteristic of the majority of the soils with the UMC landscape makes it very difficult to develop large trees within the montane forest types.

To estimate the ability for mid-closed and mid-open vegetation classes to move into the late-open vegetation class stand exam data from the ponderosa pine-Douglas-fir woodlands and the dry-mesic mixed conifer forest types were analyzed. It was determined that only a small portion of stands within the mid vegetation classes are capable of moving into the late-open vegetation class due to the lack of large trees. This analysis shows that approximately only about 25 percent of the mid vegetation class in these forest types are capable of moving from the mid to late vegetation class. It was also assumed that only the mid-open, and not the mid-closed, vegetation class is capable of moving into the late-open vegetation class based on reasons mentioned above. On the ground experience in this project area has also shown that lodgepole pine forests within this landscape follow similar trends.

Forest stands where mechanical equipment can be used have a higher probability of changing S-classes because mechanical equipment allows for a greater first entry impact when compared to areas where only hand work can be used. This is because typically more and larger trees can be removed from a treatment area which can increase the size and frequency of small and large scale canopy openings. These stands are also capable of having a variety treatment options and prescription types because the full suite of implementation options is available for use in manipulation of forest vegetation.

Thinning treatment effectiveness used to redistribute S-classes after treatment within mechanized feasible ground are as follows:

- Ponderosa Pine/Douglas-fir Woodland and Dry-mesic Mixed Conifer Forest
 - o Assumed to have a thinning treatment success rate of 100% within vegetation size classes (i.e. moving from mid-closed to mid-open or late-closed to late open).
 - o Assumed to have a thinning success rate of 25% moving from mid-open to late-open.

- Mesic Mixed Conifer
 - Assumed to have a thinning success rate of 50% for all thinning treatments in all vegetation classes.
- Lodgepole Pine Forest
 - Assumed to have a thinning success rate of 100% within vegetation size classes (i.e. moving from mid-closed to mid-open or late-closed to late open).
 - Assumed to have a thinning success rate of 25% moving from mid-open to late-open
- Gambel Oak-Mixed Montane Shrubland
 - Assumed to have a thinning success rate of 100% for all thinning treatments in all vegetation classes.

Treatments not considered to be thinnings would create large openings (2 acres and greater in size) were assumed to have a 100 percent success rate in all forest types. It should be noted that large openings can only occur in mechanized feasible ground because all treated vegetation will be removed from the treatment area.

Forest stands where manual or marginal mechanical treatment is possible typically have a lower first entry impact when compared to favorable mechanized areas. This is because these treatments can only affect portions of a stand and/or because the size and amount of forest vegetation that can be treated is limited due to tree size constraints. Concerns with activity fuel loading can also limit the scale of these treatments because treated vegetation is left on site. For analysis purposes the following success rates were used for mechanized marginal ground:

- Ponderosa Pine/Douglas-fir Woodland and Dry-mesic Mixed Conifer Forest
 - 60% success rate in for moving from a closed to open canopy condition within a vegetation class (i.e. moving from mid-closed to mid-open and late-closed to late open)
 - 25% success rate of moving from mid-open to late-open
 - 0% success rate of moving from mid-closed to late-open
- Mesic Mixed Conifer Forest
 - 40% success rate for all treatments
- Lodgepole Pine Forest
 - 60% success rate for all treatments
- Riparian Swale
 - 50% success rate for all treatments

Incomplete and Unavailable Information

Geospatial vegetation data, while mostly reliable, contains a fair amount of incorrect or unreliable data mostly driven by assumptions used during development and classification. The majority of these errors are relatively benign (i.e. small inconsistencies in stand boundaries) but a few are more substantial (i.e. misclassifying vegetation classes) and can affect treatment outcomes/impacts. Some assumptions were made during the classification of vegetation classes for the existing forest types, therefore actual distribution of these classes within the different forest types is likely different than those analyzed here. These errors could affect how or if treatments are capable of meeting the desired forest type distributions, but not to a large degree.

A slope analysis for treatment type and feasibility was performed on all identified treatment areas. A 30 meter digital elevation model (DEM) was used to calculate average slopes for a 10 meter raster grid across the landscape. This was done to identify potential areas where mechanical equipment could and could not be used. Slope analysis is critical when trying to determine mechanical treatment feasibility when compared to manual types of treatments (i.e. handwork) as the potential operational constraints and resource damage concerns are far fewer with manual treatments. There are some inherent inaccuracies when performing such an analysis because DEMs accuracy at 30 meters is not particularly precise and therefore affects accuracy of the average slope calculations for the treatment areas. Therefore there may be additional areas within the identified treatment areas that are more or less conducive to mechanical treatment and adjustments will be made during the unit layout process. Typically in projects the actual amount of operable mechanical ground declines during the layout process and field review of feasibility. In fewer cases additional operable mechanical ground is identified and “picked up” by crews during layout. In sum there will likely be adjustments made on the ground during the layout process to identified treatment areas when actual mechanical feasibility can be field verified. An acceptable tolerance for “picking up” additional mechanically operable ground should be no more than 15% of the original treatment area. The end result of field verification of treatment unit could be a slight increase or decrease in mechanical operable ground and/or in manually operable ground.

Road access for machinery and equipment needed for treatment implementation is difficult to assess at the scale of this project. It is likely that some temporary and specified roads will be needed to obtain access to treatment area locations. These roads will be designed with the assistance of Forest Service engineering personnel as needed. Road design will follow all applicable best management practices (BMPs), National Handbook and Manual direction, and applicable Forest Plan standards and guidelines. Typically these roads are obliterated and rehabilitated upon project completion.

Spatial and Temporal Context for Effects Analysis

For this analysis effects are characterized for the approximate life of the UMC project, approximately 10 years. This length of time was used because it is reasonable, thereby avoiding unnecessary speculation and it also allows for the integration of a variety of detailed analyses undertaken by the Front Range Collaborative group which provide a critical description of current and future conditions.

Past, Present, and Foreseeable Activities Relevant to Cumulative Effects Analysis

The past activities within the UMC project area are described in detail in the existing condition section of this document.

Projects occurring presently include:

- 130 acres of reforestation is being accomplished within the Waldo burn perimeter.
- Hillslope stabilization is also continuing within priority watersheds in the Waldo burn area.
- Small scale firewood removal is also occurring with select portions of Waldo.

Projects that could occur within a reasonably foreseeable future include:

- Fuel reduction treatments on private land surrounding the Palmer Lake reservoir.
- Fuel reduction treatments on Air Force Academy lands.
- Additional plating within the Waldo burn area will likely continue, 130 acres is planned for 2016 around Rampart Reservoir.
- Prescribed fire in previously treated areas along the Rampart Range road near the Rampart Reservoir.

Palmer Lake Upper and Lower Reservoir Area Agreement

As part of this project an additional analysis was performed on Forest Service managed lands surrounding the Palmer Lake Upper and Lower Reservoirs (see Figure 5 below). This area was initially removed from consideration for treatment due to the steep terrain that limits operability and because of poor access. Further discussion between UMC planning team members and the concerned citizens of Palmer Lake prompted a secondary look at this area. A downscaled analysis was done around the Upper and Lower Reservoirs to determine the mechanical feasibility as well as the possibility for using more unconventional treatments such as helicopter and cable yarding.

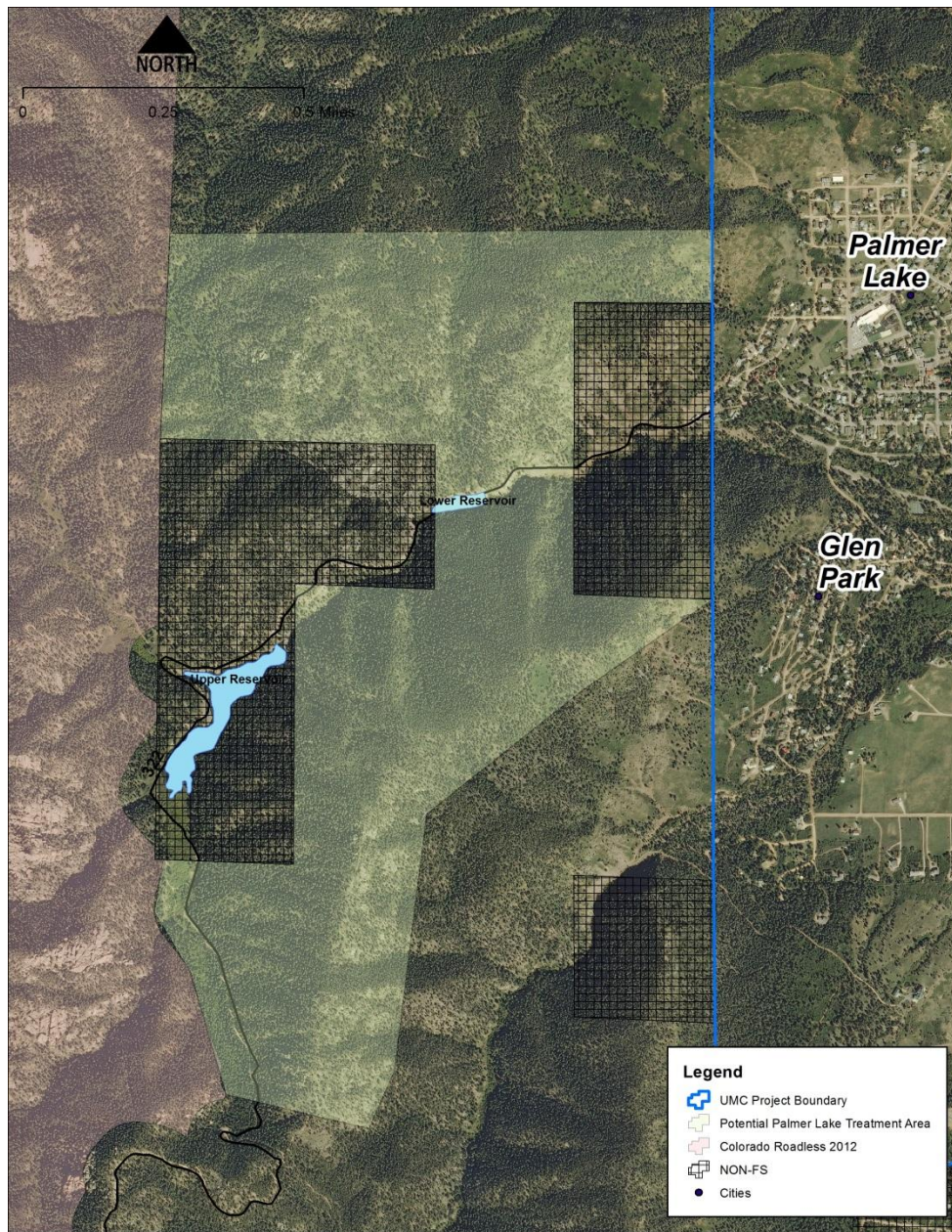


Figure 5. Potential Palmer Lake treatment area.

The steepness of slopes, limited landing locations and limited existing road access restricted the use of mechanized and cable logging systems, and while the use of helicopter yarding is feasible it was determined to be prohibitively expensive for this area. Manual treatments such as handthinning and piling or lopping of treated fuels are the most likely treatments within this area. Due to the complexity and costliness of potential treatments around the reservoirs, an agreement was reached between Forest Service leadership and the citizens of the Palmer Lake area that treatment of Forest Service managed lands would only occur if residents of the Palmer Lake area treated their private inholdings and areas surrounding the reservoir as well.

Alternative 1 – No Action

Direct Effects

There are no direct effects of choosing the no action alternative.

Indirect Effects

Recent wildfire activity on Pike National Forest lands (Hayman 2002, Waldo 2012) have demonstrated the risks that current forest conditions pose to communities and homes within the Front Range. A comprehensive analysis of a no action alternative indicates that the current conditions will continue to be perpetuated in the absence of management (Low unpublished).

Left untreated the Upper Monument Creek analysis area would continue to develop under current trajectories. Forest vegetation densities would continue to be high in many areas, resulting in high levels of competition for nutrients, light, and water which will reduce the vigor of these stands. Unnaturally high levels of shade tolerant conifers will remain on the landscape and aspen populations will likely decline from competitive stresses and senescence. As vigor continues to decline forest vegetation will be increasingly susceptible to drought stress, damage and mortality from insects and disease, and will continue to have structural characteristics that can allow for severe crown fire activity to take place across the landscape.

The lack of small and large scale forest canopy openings will continue under the no action alternative. The low severity fires that once created and maintained small scale canopy openings are unlikely to occur in the UMC landscape since forest vegetation densities will remain high and are more likely to support crown fire activity. Landscape level closed canopy conditions will also prompt fire crew to focus on immediate suppression of fires in the landscape in order to limit the possibility of a large active crown fire event. Large openings, from wildfire, could occur within the next ten years in the UMC landscape but they would most likely mimic openings created in the Hayman and Waldo fires and would therefore be uncharacteristically large and would likely have some negative long-term ecological and social impacts (i.e. loss of wildlife habitat, forest type conversion, destruction of private property).

No fuelbreaks would be installed in the UMC landscape nor would treatment of oak brush occur, which would negatively impact firefighter safety and limit the suppression and holding capacity of fire crews should a wildfire occur.

Watersheds within the analysis area will continue to be at risk for deleterious effects from severe wildfire activity and epidemic scale forest pest outbreaks. Without treatment, forest canopy density and continuity will be capable of carrying crown fire over large portions of the landscape. Reservoirs and other critical water provider infrastructure will be at high risk to damage from high severity fire during active burning as well as longer-term negative effects, such as sedimentation and soil destabilization, should a high severity fire occur.

Cumulative Effects

Under the no action alternative the reasonably foreseeable fuels projects on private land and on the Air Force Academy lands would take place, as well as the additional reforestation efforts within the Waldo burn perimeter. The effectiveness of the aforementioned fuels projects would be limited as the Forest Service managed lands within the UMC landscape would continue to be susceptible to high severity crown fire and would be conduits to carry wildfire into surrounding lands.

Prescribed burning would occur in the next ten years along the Rampart Range road near the Rampart reservoir, but without further treatment in the UMC landscape these burns would be limited in their size and ability to influence the potential fire behavior in this area.

Areas within the Waldo burn perimeter would continue to develop and reforestation will occur, but this area will remain in the early seral stages of development in the next ten years and will provide little to the spatial heterogeneity of the UMC landscape.

Summary of Effects

The no action alternative will not meet the purpose and need of the UMC project. The landscape will still be at high risk for having uncharacteristically large severe crown fire that could significantly affect watershed health and function. Dense forested stands will continue to be at risk of epidemic scale mortality from forest insects. There is a high likelihood that under the no action alternative, a similar fire of size and severity of both Hayman and Waldo Canyon would occur within the UMC project area.

Alternative 2 – Proposed Action

The proposed action for the UMC landscape is a multi-faceted integrated approach of forest vegetation manipulation that seeks to move the landscape toward the desired condition for forest restoration, fuels reduction, and watershed health and protection.

Design Features and Mitigation Measures

Common to all ecological systems:

- Retain old trees of all species to the extent possible. Use morphological characteristics such as flattened crown form, furrowed and thick platy bark, deep bark fissures, and large diameter branches as distinguishing features to identify old trees. At times old trees may need to be removed for operational purposes (landing creation) but all attempts should be made to avoid these situations and cutting of old trees should be the exception rather than the rule.
- Retain snags and downed wood to the extent possible to provide structural complexity and important wildlife value. Snags should only be felled to ensure operator safety during operations.
- Preferentially retain ponderosa pine over other conifer species.
- Emphasize and expand the presence of aspen across the treatment area. Consider “day-lighting” existing aspen patches by clearing around them to increase vigor and abundance. Where aspen is present regeneration harvests may be used to encourage aspen proliferation.

- Minimize soil disturbance by utilizing low-impact silvicultural practices. Ensure that all skid trails and landings are rehabilitated (i.e. ripped and seeded with native grasses) after operations have been completed.
- Utilize implementation methods that will help facilitate the use of fire, both prescribed and natural ignitions, at the earliest time possible after treatment.
- Monitor treatment areas for the presence of noxious weeds and take measures to eradicate and/or prevent their spread should they become established.
- Tree cutting operations will be done in a manner that minimizes damage and protects residual tree stands.

Ponderosa Pine – Douglas-fir Woodlands

The ponderosa pine–Douglas-fir ecological system is primarily at lower elevations and dry sites at higher elevations. Historically, these systems were shaped by low- to mixed-severity, frequent fire, which maintained an open stand structure with variably spaced individual trees, groups of trees, and openings. Current conditions are much denser than historical conditions for this ecological system, and thus this system is a high priority for restoration.

Management Goals

Management should be focused on reducing stand densities and restoring spatial structure via enhancement of tree groups, scattered individual trees, and openings. A predominantly uneven-aged, open stand condition that contains lesser amounts of even-aged and larger openings (one acre and larger) irregularly distributed throughout the treatment area. Treatment design criteria are summarized below:

- Residual basal area should range from 30 to 50 ft² per acre, but should be distributed according to site variability in topography and substrate characteristics such that BA in any given stand may range from 0 ft² per acre (openings) up to 80+ ft² per acre (high-density patches).
- Openings should be variable in size, shape, and distribution. Enhancing existing openings should allow for the restoration of larger openings (e.g. up to 40 acres in size), while creating new openings will enhance landscape heterogeneity and break canopy continuity. Suitable locations for openings include low-productivity areas such as shallow soils, areas currently lacking ponderosa pine, areas where disease or insect infestation are present, and plantations established from off-site seed sources. Created openings may range in size from 1 to 20 acres.
- A low-density matrix (20 to 40 ft² per acre BA). Suitable locations for low density structures include ridges, south-facing slopes, and other areas of low productivity. Residual trees should be variably spaced. Existing tree groups (i.e. trees having interlocking crowns) should be enhanced by clearing around them. Approximately 50-70 percent of trees may occur in groups, whereas the remaining 30-50 percent may occur as scattered, individual trees at low densities. Tree groups may contain anywhere from 2 to 10+ trees, but will most likely contain around 2-4 trees. Tree groups should be separated from one another by at least 1 to 1.5 tree lengths from drip-line to drip-line, based on the heights of trees in the group.
- A medium-density matrix (40 to 60 ft² per acre BA) most often at mid-slope positions and other areas of intermediate productivity, such as gentle slopes. Approximately 70-90% of trees may occur in groups here and group size may be larger as well, on the order of 5-10 trees per group typically.

- Areas of high density (60 to 80+ ft² per acre BA) on north-facing slopes and other moist, higher-productivity areas. The characteristic structure of lower-density areas (i.e. tree groups, individual scattered trees, and openings) may be less evident at this higher density level as most trees occur in groups (90+ percent) and fewer as scattered individuals.
- Untreated “reserves” representing unique ecological or cultural areas within the treatment area.
- Install fuelbreaks in tactical locations for firefighter safety, to prevent crown fire spread, and to create holding areas for prescribed fire.

Dry Mixed-Conifer Forests

Dry mixed-conifer forests often represent subtle transitions from ponderosa pine – Douglas-fir woodlands where moisture availability and the proportion of Douglas-fir both increase. Dry mixed-conifer forests are naturally denser and more productive than ponderosa pine – Douglas-fir woodlands but have similar ecological dynamics. Low-severity fire was the dominant disturbance regime historically, but with some increase in the preponderance of moderate- and high-severity fire and slightly longer fire return intervals compared to ponderosa pine – Douglas-fir woodlands. Dry mixed-conifer forests typically have greater variability in tree group composition, from single-species to mixed-species groups, and from single-aged to multi-aged groups. There is also higher potential for ladder fuel development in this system due to the higher productivity and increased proportion of Douglas-fir.

Management Goals

Management goals for the dry mixed-conifer ecological system are similar overall to those for ponderosa pine – Douglas-fir woodlands. Higher overall tree densities and a higher proportion of Douglas-fir and other conifers such as limber pine should be allowed. Treatment design criteria are summarized below:

- Residual basal area should range from 40 to 60 ft² per acre and should be distributed according to site variability in productivity, ranging from 0 ft² per acre (openings) up to 80+ ft² per acre (high-density patches).
- Openings should be variable in size, shape, and distribution. Sizes may range from 1 to 20 acres. Suitable locations for openings may include low-productivity areas such as shallow soils and areas where disease or insect infestation is present. Higher productivity areas may be suitable as well to mimic ‘blow-outs’ that occur with mixed-severity fire and to create opportunities for regeneration and early-seral habitat structures.
- A low-density matrix (20 to 40 ft² per acre BA) primarily in areas where a high ponderosa pine component (as much as 50%) is present. These areas may have been ponderosa pine – Douglas-fir woodlands prior to fire exclusion and conversion back to this woodland structure may be appropriate here. Tree groups, individual scattered trees, and openings should all be present. Approximately 50-70 percent of the trees here may occur in groups containing anywhere from 2 to 10+ trees, but most often containing 2-4 trees. The remaining 30-50 percent of trees may occur as scattered, individuals.
- A medium-density matrix (40 to 60 ft² per acre BA) with emphasis still on restoring spatial structure. More trees will occur in groups (70-90%) at this density and group size is larger, typically 5-10 trees per group. Mixed species groups are appropriate. Ponderosa pine, Douglas-fir, limber pine, and aspen may all occur.
- A high-density matrix (60 to 80+ ft² per acre BA) in higher productivity areas. Most (90 percent or more) trees may occur in groups here, with groups containing a large proportion of Douglas-fir. Blue spruce may be present here as well.

- Untreated “reserves” should cover representing unique ecological or cultural areas within the treatment area.
- Install fuelbreaks in tactical locations for firefighter safety, to prevent crown fire spread, and to create holding areas for prescribed fire.

Mesic Mixed-Conifer Forests

Mesic mixed-conifer forests are found primarily in mesic settings such as north-facing slopes and at higher elevations. The presence of Engelmann spruce often signals the transition from dry mixed-conifer to mesic mixed-conifer forests. Historically, mesic mixed-conifer forests were prone to extremes in fire activity, depending on climatic conditions. Under mild conditions they may not have burned at all, whereas during drought they may have burned with high severity. This disturbance dynamic would tend to create more of an even-aged, patch structured system as opposed to the uneven-aged matrix characteristic of drier settings. A range of structural stages would have characterized the system across the landscape, representing varying degrees of recovery following stand-replacing fire.

In general, the restoration imperative begins to fall away in more mesic forests such as mesic mixed-conifer, as these systems are not as ecologically departed from their natural range of variability compared to the drier forest systems. Treatments that are focused more on fuels reduction than restoration may also be warranted here in order to break canopy continuity and increase the potential for using prescribed fire here and in adjacent dry forests.

Management Goals

Treatments should focus on enhancing structural and age-class diversity between stands (e.g. young stands adjacent to older stands), reducing density of older stands, and reducing fuels. Creating openings and thinning older stands are both appropriate management actions here, but decisions to treat should be based on the local context and presence of values at risk. For example, a high-density patch of mesic mixed-conifer adjacent to an old-growth stand of ponderosa pine may be a candidate for treatment in order to reduce the potential for crown fire and protect the old-growth. General management goals include:

- Create large openings (10 to 20 acres in size) in early- and mid-seral stands to mimic natural disturbances such as wind throw or blow-outs that occurred historically with mixed-severity fire. Diseased or insect-infested areas may provide opportunity for creating openings. Avoid uniform shapes and spacing for openings; place openings only in areas considered to have moderate to low risk of windthrow.
- Reduce density in late-seral, closed stands in order to release large, old trees and accelerate development of structural complexity and old-growth features. Focus on removal of small-diameter trees and ladder fuels.
- Leave a high proportion of the total area in mesic-mixed conifer untreated. Closed forests interspersed with open, drier forests provide a natural and desirable landscape pattern. These “dark timbered” areas are important for wildlife as well.
- Install fuelbreaks in tactical locations for firefighter safety, to prevent crown fire spread, and to create holding areas for prescribed fire.

Lodgepole Pine Forests

The lodgepole pine ecological system is primarily along the Rampart Range Road within the north-central part of the project area. Lodgepole pine stands consist of a diverse range of structural types, from late-seral, uneven-aged stands to younger, even-aged stands. The late-seral, uneven-aged stands within the project area appear to be a somewhat rare compositional and structural type for lodgepole pine. They are dominated by lodgepole pine but also include a diverse suite of additional species such as Douglas-fir, limber pine, aspen, and occasionally ponderosa pine. These stands are relatively open with patches of well-developed understory and old trees. Some evidence of surface fire is present throughout these stands as well. Small-scale tree mortality and regeneration processes appear to be operating in these stands, consistent with uneven-aged stand dynamics. In general, late-seral stands occur along flat ridges of the Rampart Range and grade downslope into younger, even-aged stands, particularly on north-facing slopes. These younger stands likely represent recovery from stand-replacing fire and are more typical of lodgepole pine in that they exhibit fairly uniform stand structure and sparse understory vegetation. Stands that are regenerating from clearcuts in the 1960s and 1970s are also present. These stands exhibit the classic “dog-hair” structure of young lodgepole stands.

Overall however, lodgepole pine in the project area does not appear to be significantly departed from historical conditions for this system type. A suitable range of seral stages are represented at appropriate scales, and the stands currently appear healthy and have not been significantly impacted by the mountain pine beetle.

Management Goals

While ecological restoration is not a high priority for lodgepole pine within the Upper Monument Creek landscape, the system’s proximity to other high priority ecological systems may warrant a fuels-based treatment approach. Fuels reduction within the lodgepole pine system will increase the likelihood of being able to use prescribed fire in downslope ponderosa pine – Douglas fir woodlands and dry mixed-conifer forests, potentially advancing larger landscape restoration goals. Such treatment would also serve to protect the late-seral lodgepole pine stands identified as unique on the landscape. Overall, the goal of these treatments would be to reduce fuel loads and canopy continuity, increase structural diversity and resilience to fire and mountain pine beetle, encourage aspen cover, and move younger, more uniform stands in the direction of late-seral stand structures. Openings should be created to slow the rate of spread and break the direction of an active crown fire, and treatments. Treatments should avoid homogenous patterns such as evenly spaced openings of the same size and even-spacing of trees. General recommendations include:

- Minimize treatments in late-seral, uneven-aged stands; target mid-seral and closed stand structures. Pay particular attention to minimizing windthrow during treatment design.
- Install patch clearcuts ranging from 3-20 acres in size targeting mid-closed structure classes.
- Elsewhere within the treatment footprint, create both small (<1 acre) and large (1-5 acres) openings via an uneven-aged, group selection approach.
- Place openings greater than 1 acre only in areas considered to have moderate-to-low risk of windthrow.
- Where feasible, locate larger openings adjacent to drainages to enhance aspen sprouting.
- Utilize precommercial thinning in sapling-size lodgepole pine areas, but leave some denser thickets for wildlife cover.

- Install fuelbreaks in tactical locations for firefighter safety, to prevent crown fire spread, and to create holding areas for prescribed fire. Target areas along roadways and in areas along the Roadless boundary.

Gambel Oak – Mixed Montane Shrublands

Gambel oak – mixed montane shrublands occupy lower elevation, dry settings along the eastern flank of the project area near Monument, as well as in the vicinity of Woodland Park. This ecological system occurs both as an oak-dominated shrubland and as more of an understory component within the ponderosa pine – Douglas-fir woodland. As one of the few deciduous tree species present within the project area, Gambel oak adds species diversity and has an important role for wildlife in terms of both cover and forage.

Given its low-elevation range restriction, Gambel oak likely experienced frequent fire historically, which would have maintained a more open and diverse structural condition than seen on the current landscape. Gambel oak is likely over-represented on today's landscape due to fire exclusion. A range of growth forms from large individual trees to shrubby thickets were likely present historically. A rich understory community of grasses, forbs, and shrubs was likely present as well. The area around Monument is currently composed of dense, uniform Gambel oak following recovery from the 1989 Berry fire. Very little structural diversity occurs here and the area represents high potential for stand-replacing fire. Furthermore, the area is highly visible given its location and may provide opportunity for the Forest Service to potentially complement existing treatments and spurring new treatments on neighboring private lands.

Management Goals

Management goals within the Gambel oak ecological system are to reduce fuels, increase structural diversity, and break canopy continuity where uniform canopy cover exists. Where possible, prescribed fire should be used to reduce fuel loads, increase structural heterogeneity, and enhance understory herbaceous vegetation. General treatment design recommendations include:

- Protect ponderosa pine islands and individual trees by removing Gambel oak and other woody brush that may serve as ladder fuels.
- Remove Gambel oak in the vicinity of ponderosa pine seed trees in order to encourage regeneration and establishment of ponderosa pine.
- Install fuel breaks as necessary within this ecological system. Target areas where land ownership changes, along roadways, and in the ecological transition zones between forest types.
- Manage for variation in oak growth forms, sizes, age-classes, densities, and spatial distribution.
- Maintain large, old oak trees.

Riparian swales

Riparian swales are distributed throughout the UMC project area and are typically found in between draws and in valley bottoms bounded by upland forests. The vegetation within these areas is highly variable and can range from nearly pure even-aged aspen stands to conditions and structures that closely mimic uneven-aged mesic mixed conifer forests. Trees in these areas are typically larger than the surrounding upland site due to the alluvial soils and mesic conditions that

classify these areas. The better growing conditions of these areas can support greater tree densities than more upland sites and typically have two to three distinct canopy classes.

The mesic conditions that typify these areas do not tend to favor frequent low intensity fire. More typically these areas are prone to high intensity and severity fires that occur infrequently. These fires tend to originate in upland sites and can carry into wetter riparian swales sites during optimum burning conditions and/or during extended drought periods when riparian swale areas are much drier than normal. The good growing conditions, capacity of maintaining high levels of tree density and typically infrequent fire return intervals means that fuel loadings in these areas can be relatively high under normal conditions.

Riparian swales and corresponding vegetation are important components of the larger watershed health as they serve as filters for upland sedimentation, buffer overland flow of water, and provide hydrological input into larger stream classes.

Management Goals

Management goals within the riparian swale ecological system are to reduce fuels, increase structural diversity, break canopy continuity where uniform canopy cover exists, perpetuate vigorous aspen clones, and protect and enhance the large conifer component of these systems. Where possible, prescribed fire should be used to reduce fuel loads, increase structural heterogeneity, and enhance understory herbaceous vegetation. General treatment design recommendations include:

- Protect and enhance aspen clone vigor by removing conifer encroachment.
- Reduce the density of understory and midstory conifers to lower the amount of ladder fuels.
- Release and protect large streamside conifers from surrounding conifer competition.
- Regenerate decadent aspen clones to maintain the aspen component of these areas.
- Prune large streamside conifer, to no less than 40% live crown ratio, to lessen the chances of crown scorch and potential for torching where possible.

Aspen Stands

Occupying moist, nutrient-rich sites, aspen stands contain an abundance of biodiversity, exceeded only by riparian zones (White et al 1998). Aspen dominated communities are of major importance to ecosystem function, forage production, and vegetative biodiversity. When functioning properly, they provide forage and habitat for wildlife, water, esthetics, recreational sites, and landscape diversity. When not functioning properly, many of these values are compromised and can result in conifer encroachment, loss of understory vegetation, and decline of forage production (Bartos 2000). In the UMC project area, aspen stands are in decline and many are not functioning at their full potential.

Historically found in early seral stages and forest openings, aspen is a disturbance-dependent species that is well adapted to frequent fire regimes. At higher elevations, aspen would have dominated historical forest openings, but fire suppression has allowed conifers to encroach on aspen stands, ultimately outcompeting and replacing the aspen (Stam et al 2008). With fire, aspen stems die within 1-5 years, but the root system typically remains unharmed and responds by producing prolific suckers within the first growing season after the fire (Romme et al....). Aside from stimulating suckering, fire also increases understory production of grasses and forbs and removes competing overstory and seedling conifers (Shepperd 2001). In addition to disturbance,

aspen also require direct sunlight as they cannot survive or reproduce under the shade of competing vegetation, which becomes an issue with the progressive encroachment of conifers (Stam et al 2008).

Fire suppression in the UMC project area has led to a combination of these factors resulting in the decline of aspen stand structure and function across the landscape. With the lack of fire, there is little disturbance to stimulate suckering, which results in very few aspen being produced each year. Vegetative regeneration of aspen require stimulation to initiate the root suckering response (Shepperd 2001). In the absence of disturbance, coniferous species frequently establish, outcompete the aspens, and ultimately dominate the site. The subsequent shade from the coniferous species also prevents aspen suckers from successfully establishing and the stand is unable to regenerate. The initiation of bud growth must also be accompanied by sufficient sunlight and warmer temperatures at the forest floor to allow new suckers to thrive (Shepperd 2001). As a result, the age structure of aspen stands has shifted towards an increasing prevalence of older, even aged stands, which are more susceptible to disease and mortality.

Management Goals

Management goals within aspen stands within all ecological systems are to maintain, enhance, and expand Quaking aspen stands for vegetative diversity across the landscape and for forage, cover, nesting for numerous species. Fire suppression, conifer encroachment, and disease have caused a landscape-wide decline in aspen stands and degradation of overall habitat quality. These conditions may result in the loss of key habitat elements for species in the UMC landscape.

- Individual aspen trees and aspen stands would be retained and enhanced using vegetation management treatments and techniques that are most ecologically appropriate to each unique stand. Choosing the appropriate technique for a given aspen stand depends on its age, vigor, stocking, associated vegetation, accessibility, and the abundance of other aspen on the landscape (Shepperd 2001). Successful vegetative regeneration of aspen is dependent upon three key components: hormonal stimulation (disturbance event), the growing environment (full sunlight, warmer temperatures) and protection of new suckers (ungulate browse, vegetation competition) (Shepperd 2001).
 - In coniferous stands in which there is an aspen component, prescriptions would be designed to promote aspen cover.
 - Existing aspen patches would be “day-lighted”, in which vegetation around them will be cleared to increase vigor and abundance.
- Aspen stand vigor would be protected and enhanced by removing conifer encroachment.
 - Aspen stands would be restored by removing competing vegetation, allowing more sunlight to reach the understory and providing the aspen more growing space in the root system.
 - Competing conifers would be removed by selective cutting or girdling.
 - Habitat features would be maintained and enhanced by encouraging the development of mature aspen stands.
 - An increase in the spatial heterogeneity of aspen will limit the suitable habitat and dispersal potential of Douglas fir tussock moth populations.
- Aspen restoration would be encouraged in aspen stands that are decadent or in which recruitment is deficient to encourage the development of a new vigorous cohort.

- Regeneration methods (e.g., clearcut) would be employed to promote the propagation of new suckers and establish vigorous aspen stands in a variety of age classes. Mechanical removal of overstory stems is known to produce aspen suckers and does not damage the parent root system (Shepperd 2001).
- Prescribed fire would be employed to remove encroaching conifers and to promote aspen suckering. Fire meets all the requirements for aspen regeneration. It stimulates suckering by killing overstory stems allowing new stems to emerge, removes competing understory vegetation, and it allows sunlight to reach the forest floor. The vegetation consumed by the fire injects nutrients for new suckers and the blackened surface warms soil in the root zone, further stimulating sucker growth (Shepperd 2001).
- Aspen stands would be manipulated to stimulate new growth. Potential methods include selective cutting, girdling, pushing over mature aspen stems with a dozer, severing aspen roots of parent stems, and ripping the perimeter of a decadent aspen clone, etc.
- Seeding, and the planting of seedlings and/or stem or root cuttings may occur where aspen is desired but not present to reestablish aspen in an area where it has been lost.
- Where feasible, larger openings would be located adjacent to drainages to enhance aspen sprouting (e.g., within the lodgepole pine forested vegetation system).
- Residual trees or slash would be retained or removed from treated aspen stands depending on objectives or site conditions. Slash can act as a barrier to herbivory and browse of new, delicate suckers.
- Barriers would be employed to protect aspen regeneration from herbivory, when necessary.
- Fencing would be constructed to prevent the browsing of aspen suckers by ungulates. Deer and elk foraging in these stands cause significant browsing injuries to aspen suckers and small saplings. Intense, chronic browsing on aspen suckers by wildlife has also suppressed or eliminated regeneration in aspen stands thereby reducing aspen ecosystem resilience (Seager et al 2013).
- Barriers of felled trees or hinge trees would be arranged as to impede ungulate access (e.g., jackstraw method).

Direct Effects

Direct and indirect effects of treatments to upland coniferous forest and woodland vegetation

Thinning of forest vegetation is a technique used to reallocate growing space to preferred individuals or groups of trees (Smith et al. 1997, Tappeiner et al. 2007). Trees are preferentially harvested or left untreated based on desired outcomes for a given treatment area. Currently forest thinnings that seek to mimic and recreate historic forest structures and densities (restoration based methods) are regarded as best management practices for dry coniferous forests in the west where there is a desire to return fire to the landscape (Abella and Springer 2015, Stoddard et al. 2015, Dickinson 2014, Churchill et al. 2013, Fiedler et al. 2007, Kauffman et al. 2001, Covington and Moore 1994). Additionally, thinnings and forest restoration based treatments have been

shown to significantly influence wildfire severity (Yocom Kent et al. 2015, Waltz et al. 2014, Stephens et al. 2009, Agee and Skinner 2005). Specific guidelines for thinning treatments for each of the ecological systems within the UMC project area will follow the aforementioned design criteria in this document.

Thinning of forest trees directly impacts: the average stand diameter (increase in a thin from below, and decrease in a thin from above), species composition, stand density (i.e. trees per acre and basal area), the amount and distribution of diseased and pest infested trees, stand canopy cover, the average live crown ratio, crowning indices (i.e. the minimum windspeed for maintaining crown fire activity), the average crown base height (i.e. thin from below), canopy and crown bulk density, and can release occupied growing space to residual trees or to non-tree understory vegetation like grasses, herbs, and forbs (Abella and Springer 2015, Cram et al. 2015, Strahan et al. 2015, Yocom Kent et al. 2015, Churchill et al. 2013, Stephens et al. 2009, Agee and Skinner 2005).

The amplitude of the effects of thinning depends on the intensity to which forests are thinned. Less intense thinnings where few trees or trees in lower strata are removed can have a minimal effect on the tree and stand characteristics. More intense thinnings where trees are removed from all of the existing strata will yield more significant effect to treated areas. The design criteria developed for this project will provide for a variety of forest structures and densities across the landscape by utilizing a spectrum of treatment intensities.

Growing space released by forest thinnings can have a variety of indirect impacts on forest vegetation. Low intensity thinnings where little growing space is released will likely only produce nominal increase in understory biomass (grasses, forbs and herbs) and most of the released growing space will be reoccupied by remaining trees and/or established understory vegetation. More moderate and intense levels of thinning can release enough growing space where remaining vegetation cannot easily sequester newly available nutrients and sunlight. In these areas there will be an increase in understory response and grasses, forbs, and herbaceous vegetation will become established. Tree regeneration can also occur in these treatments, especially where aspen is found, and a variety of species could become established.

Areas where larger openings are installed or enhanced the effects of released growing space will be more pronounced. Initially these areas will begin to fill in with grasses, shrubs, forbs, and herbaceous vegetation. If aspen originally occupied the opening site or if clones are located along the perimeter of the openings then a flush of aspen suckers will also initialize into these sites. Any overstory conifers left in openings will see a major reduction in competitive stressors which will increase the vigor of these trees to some degree. Broad scale conifer regeneration will eventually occur in these openings, the timing which will depend on distance to seed source, seedbed availability, and favorable climatic windows.

Increases in spatial heterogeneity and tree vigor will also affect forest insects and pathogens. Western spruce budworm populations will likely decrease as Douglas-fir densities decrease across the project area. Increases in spatial heterogeneity and in the pine and aspen component of treated areas will limit the suitable habitat and dispersal potential of tussock moth populations. Increases in the overall vigor of residual trees will help limit the potential for epidemic outbreaks of bark beetle populations. There will also be an overall reduction in the dwarf mistletoe infected trees across the project area as they will be targeted for removal.

There are additional indirect effects that could occur by implementing the proposed action. During project implementation there will likely be restricted road usage and noise from

machinery that could lessen recreational experiences in the area. More open conditions in project area forests could add to the user created trail issues that currently plague the Forest. Existing user created trails that lie within project areas would be rehabilitated after project completion. Wildlife could also be deterred from project areas during implementation, but these effects would be short term.

Direct effects to vegetation class distribution

Forest vegetation treatments utilizing the aforementioned design criteria would directly affect the distribution and arrangement of vegetation classes within the major ecological systems found in the UMC landscape. The feasibility analysis described in the Methods section above was used to generate an anticipated number of potential treatment acres for each of the ecological systems. It should be noted that not all of the acreages listed in the table below will be treated, and further discussion of treatment intensities and effects is provided in the sections below. There will also be on the ground adjustments made to treatment unit boundaries as actual feasibility limitations and opportunities are better identified. An estimation of acres that can potentially be treated within the UMC project area for each of the ecological systems is provided in Table 12 below. Figure 6 below is the spatial representation of the proposed action for the UMC project area.

Table 13. Summary of potential treatment acres by ecological system and vegetation class.

Ecological system	Vegetation class				
	Early	Mid-closed	Mid-open	Late-open	Late-closed
Ponderosa pine/Douglas-fir Woodland					
Mechanized feasible	82	877	474	168	579
Mechanized marginal	39	3,151	920	501	1,013
Dry-mesic mixed conifer forest					
Mechanized feasible	237	1,201	397	77	165
Mechanized marginal	16	2,407	683	188	438
Mesic mixed conifer forest					
Mechanized feasible	0	1,108	75	68	536
Mechanized marginal	2	2,548	89	59	575
Lodgepole Pine Forest					
Mechanized feasible	17	802	255	362	777
Mechanized marginal	0	36	363	58	224
Gambel oak-mixed montane shrubland					
Mechanized feasible	0	458	368	0	0
Mechanized marginal	0	0	0	0	0
Riparian swale					
Mechanized feasible	0	0	0	0	0
Mechanized marginal	16	2,617	935	8	364

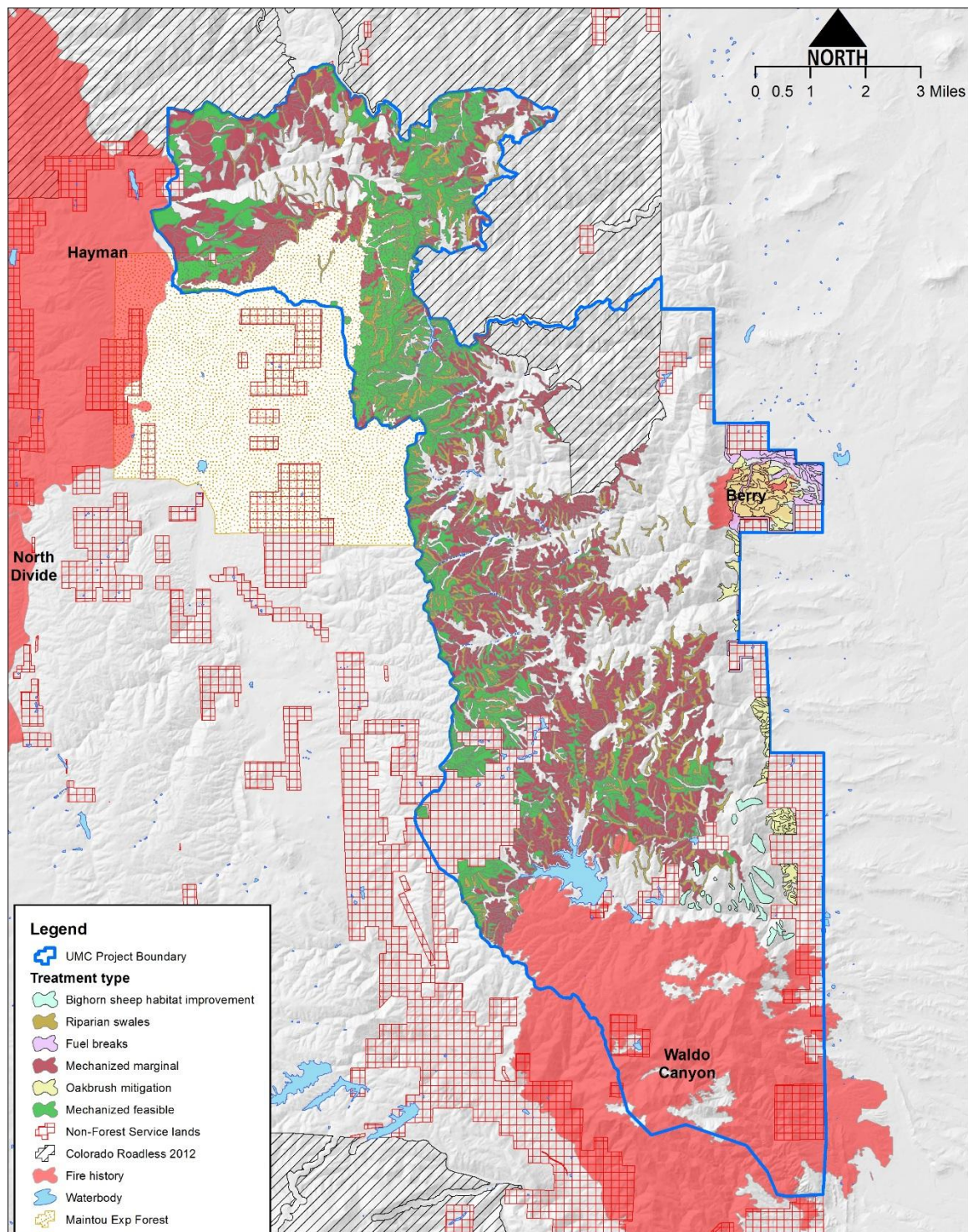


Figure 6. The distribution of proposed action treatments in the UMC landscape.

Ponderosa Pine – Douglas-fir Woodlands

Under the proposed action approximately 2,180 acres would be available for mechanized treatment and an additional 5,624 acres of marginal mechanized ground would be available for treatment. Prescribed treatments will follow the design criteria for this forest type so that stand structure and distribution will move toward the natural range of variation. The focus of treatments within the mechanized ground would be to create and enhance interspatial openings, tree groupings at varying densities, and large openings within the ponderosa pine-Douglas-fir woodland type.

Acres currently in the early vegetation class would remain following treatment. Treatments within this vegetation class would enhance the already established low density and openness in these areas. Advanced regeneration could be removed as well as ladder fuels that could serve as conduits for fire along stand edges or that could pose a threat to old established remnant trees that could exist. Treatments would encourage understory growth of grasses, forbs, and herbaceous plants by removing competing tree vegetation. Treatments would allow for fire to play a more natural role in these stands once treatments established a more natural density and distribution of established trees.

The mid vegetation classes would receive the full suite of treatments under the proposed action. Approximately half of the mid-closed class and one-third of the mid-open class would be converted to the early vegetation class by installing large openings (2 acres and greater) across the landscape. Openings will vary in size and arrange across the project area and will be larger than 2 acres but less than 40 acres and on average 5-10 acres in size. Residual large diameter and old trees would be left at varying densities within these openings to serve as seed sources for future regeneration, as critical structural components for forest vegetation, and as future standing soft snags and eventually large woody debris for the forest floor. Eventually openings would foster the development of new early seral forest stands that would be comprised of conifer and aspen regeneration. Regeneration of these openings could occur as soon as five years after treatment depending on climate and seed availability. Openings will be allowed to regenerate within the 7D management area where timber production standards require full stocking within five years after such treatments to meet Forest Plan and NFMA requirements. If natural regeneration is found to be insufficient in 7D management areas, artificial regeneration/planting could be necessary to ensure that Forest Plan direction and NFMA requirements for stocking are met. There are stands within the Upper Monument Creek watershed that were planted in the early 20th century with questionable tree stock that appear to be offsite and are performing poorly and are potential sources of poor genetics. These areas are ideal for both clearcutting of offsite poor genetic stock and replanting of native onsite superior genetic stock to ensure regeneration of these openings.

The other half of the existing mid-closed and all of the remaining mid-open class would be treated with restoration based treatments that emphasize interspatial openings and tree groupings to disrupt canopy continuity. These areas would see an overall reduction in basal area, and increase in openings between groups of trees, a reduction in ladder fuels, an increase in crown base height, and increase in understory grasses, forbs, and herbs. The distinction between large openings and interspatial openings and tree group enhancement would not be discrete structures on the landscape. Rather, they would all flow seamlessly together to form a complex distribution of forest structures across the project area. It is estimated that 50 percent of the existing mid-closed class and 75 percent of the mid-open class not put into large openings will be in the mid-open vegetation class after treatment. Approximately 25 percent of the mid-open acreage not put

into openings and that will receive the restoration based treatments will move in to the late-open vegetation class due to an increase in the average tree diameter after treatment.

The late-open vegetation class is the only late class to receive treatment in the proposed action. No large openings will be established in this class. The treatments will instead focus on increasing interspatial openings between tree groups, breaking up canopy continuity, and enhancing the aspen component of these areas. These areas would see an overall reduction in basal area, and increase in openings between groups of trees, a reduction in ladder fuels, and increase in understory grasses, forbs, and herbs. The treated acres in this class will remain in the late-open condition they are currently in after treatment but will be at a much lower density than the existing condition.

In the marginal mechanized ground approximately all of the 5,624 acres would receive some form of treatment. The steepness of the ground in these area will present operational limitations to what can be accomplished during a first entry. Stands within the early vegetation class will remain in this after treatment as silvicultural goals in these areas will be to enhance and maintain the early seral structural qualities that define this class by removing advanced regeneration or other established trees.

Changes to the mid vegetation classes will mostly occur in the mid-late component. Thinnings in these areas will expand on and create more openness between groups of trees to mimic more historic structures. Treatments will emphasize maintaining and protecting large old trees, removing much of the shade tolerant seedling and sapling size trees that have filled in interspatial openings, and removing coniferous competition within and surrounding aspen clones. When possible a mix of tree ages and sizes will be maintained to move toward a more uneven-aged structure within these stands. These areas will see a reduction in canopy cover that will move them into the mid-open vegetation class at a frequency described in the methods above.

Within the mid-open class it is expected that approximately 25% of treated stands will increase in average diameter size, by cutting trees from smaller size classes, which will move them into the late-open vegetation class. Treatments in this class will be similar to those in the mid-closed class but at a lesser intensity due to the lower amount of tree stocking that characterizes this vegetation class.

The late vegetation classes would follow a similar trajectory to the mid vegetation class in that the late-closed class would receive much of the treatment. The late-closed vegetation class would be thinned to increase the interspatial openings between tree groups so that tree group structure could be emphasized and breaks in the canopy could be created. Thinnings and breaks in the canopy would be created so that some of these stands would move into the underrepresented late-open class. Intermediate and suppressed trees would be removed between groups of dominant and codominant trees so that the overall canopy cover is reduced and the average stand diameter would increase, thus moving a portion of these stands into the late-open class. Despite that the late-closed vegetation is underrepresented the proposed action assigns treatment to this class to move some of this acreage into the more underrepresented late-open class. This was done for a couple of reasons, namely it will help break up the canopy continuity in portions of the landscape and since there is a lack of opportunity to move mid-open stands into late-open it seemed logical to move late-closed to late-open where large trees and operational feasibility allow.

Table 14. Ponderosa pine/Douglas-fir woodland distribution summary.

Class	Early	Mid-closed	Mid- open	Late-open	Late-closed	Total
Existing (ac)	387	8,124	3,810	1,897	3,119	17,337

Treatment (ac)	121	4,028	1,394	669	1,592	7,804
Outside of treatment (ac)	266	4,096	2,416	1,228	1,527	9,533
Post treatment (ac)	1,738	5,356	4,997	2,735	2,511	17,337
Post treatment (% of total)	10	31	29	16	14	100
NRV (%)	10	10	15	45	20	100

Dry-mesic Mixed Conifer Forest

Under the proposed action approximately 2,077 acres would be available for mechanized treatment and an additional 3,732 acres of marginal mechanized ground would be available for treatment. Prescribed treatments will follow the design criteria for this forest type so that stand structure and distribution will move toward the natural range of variation. The focus of treatments within the mechanized ground would be to create and enhance interspatial openings, tree groupings at varying densities, and large openings within the dry-mesic mixed conifer forest type.

Areas currently in the early vegetation class would remain following treatment. Treatments within this vegetation class would enhance the already established low density and openness in these areas. Advanced regeneration could be removed as well as ladder fuels that could serve as conduits for fire along stand edges or that could pose a threat to old established remnant trees that could exist. Treatments would encourage understory growth of grasses, forbs, and herbaceous plants by removing competing tree vegetation. Treatments would allow for fire to play a more natural role in these stands once treatments established a more natural density and distribution of established trees.

The mid vegetation classes would receive the full suite of treatments under the proposed action. Approximately half of the mid-closed class would be converted to the early vegetation class by installing large openings (2 acres and greater) across the landscape. Openings will vary in size and arrange across the project area and will be larger than 2 acres but less than 40 acres and on average 5-10 acres in size. Residual large diameter and old trees would be left at varying densities within these openings to serve as seed sources for future regeneration, as critical structural components for forest vegetation, and as future standing soft snags and eventually large woody debris for the forest floor. Eventually openings would foster the development of new early seral forest stands that would be comprised of conifer and aspen regeneration. Regeneration of these openings could occur as soon as five years after treatment depending on climate and seed availability.

Openings will be allowed to regenerate within the 7D management area where timber production standards require full stocking within five years after such treatments to meet Forest Plan and NFMA requirements. If natural regeneration is found to be insufficient in 7D management areas artificial regeneration/planting could be necessary to ensure that Forest Plan direction and NFMA requirements for stocking are met. There are stands within the Upper Monument Creek watershed that were planted in the early 20th century with questionable tree stock that appear to be offsite and are performing poorly and are potential sources of poor genetics. These areas are ideal for both clearcutting of offsite poor genetic stock and replanting of native onsite superior genetic stock to ensure regeneration of these openings.

The other half of the existing mid-closed and all of the mid-open class would be treated with restoration based treatments that emphasize interspatial openings and tree groupings to disrupt

canopy continuity. These areas would see an overall reduction in basal area, and increase in openings between groups of trees, a reduction in ladder fuels, an increase in crown base height, and increase in understory grasses, forbs, and herbs. The distinction between large openings and interspatial openings and tree group enhancement would not be discrete structures on the landscape. Rather, they would all flow seamlessly together to form a complex distribution of forest structures across the project area. It is estimated that 50 percent of the existing mid-closed class and 75 percent of the mid-open class not put into large openings will be in the mid-open vegetation class after treatment. Approximately 25 percent of the mid-open will move into the late-open vegetation class due to an increase in the average tree diameter after treatment.

The late-open vegetation class is the only late class to receive treatment in the proposed action. No large openings will be established in this class. The treatments will instead focus on increasing interspatial openings between tree groups, breaking up canopy continuity, and enhancing the aspen component of these areas. These areas would see an overall reduction in basal area, and increase in openings between groups of trees, a reduction in ladder fuels, and increase in understory grasses, forbs, and herbs. The treated acres in this class will remain in the late-open condition they are currently in after treatment but will be at a much lower density than the existing condition.

In the marginal mechanized ground approximately all of the 3,732 acres would receive some form of treatment. The steepness of the ground in these area will present operational limitations to what can be accomplished during a first entry.

Areas currently in the early vegetation class would remain following treatment. Treatments within this vegetation class would enhance the already established low density and openness in these areas. Advanced regeneration could be removed as well as ladder fuels that could serve as conduits for fire along stand edges or that could pose a threat to old established remnant trees that could exist. Treatments would encourage understory growth of grasses, forbs, and herbaceous plants by removing competing tree vegetation. Treatments would allow for fire to play a more natural role in these stands once treatments established a more natural density and distribution of established trees.

Changes to the mid vegetation classes will mostly occur in the mid-late component. Thinnings in these areas will expand on and create more openness between groups of trees to mimic more historic structures. Treatments will emphasize maintaining and protecting large old trees, removing much of the shade tolerant seedling and sapling size trees that have filled in interspatial openings, and removing coniferous competition within and surrounding aspen clones. When possible a mix of tree ages and sizes will be maintained to move toward a more uneven-aged structure within these stands. These areas will see a reduction in canopy cover that will move them into the mid-open vegetation class at a frequency described in the methods above.

Within the mid-open class it is expected that approximately 25% of treated stands will increase in average diameter size, by cutting trees from smaller size classes, which will move them into the late-open vegetation class. Treatments in this class will be similar to those in the mid-closed class but at a lesser intensity due to the lower amount of tree stocking that characterizes this vegetation class.

The late vegetation classes would follow a similar trajectory to the mid vegetation class in that the late-closed class would receive much of the treatment. The late-closed vegetation class would be thinned to increase the interspatial openings between tree groups so that tree group structure could be emphasized and breaks in the canopy could be created. Thinnings and breaks in the

canopy would be created so that some of these stands would move into the underrepresented late-open class. Intermediate and suppressed trees would be removed between groups of dominant and codominant trees so that the overall canopy cover is reduced and the average stand diameter would increase, thus moving a portion of these stands into the late-open class. Despite that the late-closed vegetation is underrepresented the proposed action assigns treatment to this class to move some of this acreage into the more underrepresented late-open class. This was done for a couple of reasons, namely it will help break up the canopy continuity in portions of the landscape and since there is a lack of opportunity to move mid-open stands into late-open it seemed logical to move late-closed to late-open where large trees and operational feasibility allow.

Table 15. Dry-mesic mixed conifer forest and woodland distribution summary.

Class	Early	Mid-closed	Mid-open	Late-open	Late-closed	Total
Existing (ac)	648	7,923	4,073	1,326	1,456	15,426
Treatment (ac)	253	3,608	1,080	265	603	5,020
Outside of treatment (ac)	395	4,315	2,993	1,061	853	9,617
Post treatment (ac)	2,147	5,278	4,949	1,859	1,193	15,426
Post treatment (% of total)	14	34	32	12	8	100
NRV (%)	10	5	20	40	25	100

Mesic Mixed Conifer Forest

Under the proposed action approximately 1,787 acres would be available for mechanized treatment and an additional 3,309 acres of marginal mechanized ground would be available for treatment. Prescribed treatments will follow the design criteria for this forest type so that stand structure and distribution will move toward the natural range of variation.

Treatments within the mechanically feasible ground will focus mainly on the mid-closed and the late-closed vegetation classes. The overrepresentation of the mid-closed vegetation class in the UMC landscape provides an opportunity to create additional early vegetation class structure via large openings (2 acres and greater in size) with the mid-closed stands within the project area. Openings will vary in size and arrange across the project area and will be larger than 2 acres but less than 40 acres and on average 10-20 acres in size. Residual large diameter and old trees would be left at varying densities within these openings to serve as seed sources for future regeneration, as critical structural components for forest vegetation, and as future standing soft snags and eventually large woody debris for the forest floor. Eventually openings would foster the development of new early seral forest stands that would be comprised of conifer and aspen regeneration.

Approximately half of the late-closed vegetation class will be treated in mechanically feasible ground. Treatments will focus on reducing the existing basal area, breaking up canopy continuity, retaining large and old overstory tree, and emphasizing complex uneven-aged structure when possible. Areas with moderate-to-high levels of insect damage (i.e. western spruce budworm defoliation) and areas where vigorous aspen clones can be released or provided expanded growing space will be targeted for treatment. These treatments will focus on increasing the within stand spatial heterogeneity and are expected to move approximately half of the existing late-closed vegetation class into the underrepresented late-open vegetation class.

Treatments within the marginal mechanized ground will focus entirely within the mid vegetation class. Treatments will focus on the understory and mid-story canopy classes with goals of reducing the existing basal area, breaking up canopy continuity, retaining large and old overstory tree, and emphasizing complex uneven-aged structure when possible. Areas with moderate-to-high levels of insect damage (i.e. western spruce budworm defoliation) and areas where vigorous aspen clones can be released or provided expanded growing space will be targeted for treatment. Treatments with the mid-closed vegetation class area expected to move 40 percent of the existing acreage into the mid-open class. Treatments within the mid-open class will enhance and maintain the existing open structure of these areas and will not shift the distribution of this vegetation class.

The table below provides a summary of the anticipated distribution of vegetation classes within the UMC project area after treatments are completed. The “Existing” field is the current distribution of vegetation classes for the forest type for the entire UMC project area. The mechanically feasible and mechanically marginal treatment acres are combined in the “Treatment acres” field. The “Outside of treatment” field corresponds to all of the acreages within the forest type that lie within the UMC project area boundary but do not fall within either the mechanically feasible or mechanically marginal designations. The “Post treatment” field is the anticipated distribution of vegetation classes after the project is complete, and the percentages of this distribution can be compared to the natural range of variation (NRV) in the final field of the table.

Table 16. Mesic mixed conifer distribution summary.

Class	Early	Mid-closed	Mid-open	Late-open	Late-closed	Total
Existing (ac)	155	9,232	631	299	2,686	13,003
Treatment acres (ac)	2	3,692	164	127	1,111	5,096
Outside of treatment (ac)	153	5,540	467	172	1,575	7,907
Post treatment (ac)	1,263	7,090	1,665	567	2,418	13,003
Post treatment (% of total)	10	55	13	4	19	100
NRV (%)	10	25	20	15	30	100

Lodgepole Pine Forest

Under the proposed action approximately 2,214 acres would be available for mechanized treatment and an additional 681 acres of marginal mechanized ground would be available for treatment. Prescribed treatments will follow the design criteria for this forest type so that stand structure and distribution will move toward the natural range of variation.

Treatments within the mechanically feasible ground in this forest type would focus on creating openings within the mid- and late-closed vegetation classes to increase the amount of the underrepresented early vegetation class. Patch clearcuts ranging from 3-20 acres would be used to a large degree within the mid-closed vegetation class and to a lesser degree within the late-closed vegetation class. In addition, treatments would create both small (less than 1 acre) and large (1-5 acres) openings via an uneven-aged, group selection approach typically in the late-closed vegetation class where complex forest structures can be found and emphasized. Openings and group selections will lower the acreage of mid- and late-closed vegetation classes while increasing the amount of underrepresented early vegetation class.

Treatments within the mechanically marginal ground of this forest type will focus on mid- and late-open and late-closed vegetation classes. Treatments will focus on the understory and mid-

story canopy classes with goals of reducing the existing basal area, breaking up canopy continuity, increasing the average stand diameter, retaining large and old overstory trees, and emphasizing complex uneven-aged structure when possible. It is anticipated that 60 percent of the existing late-closed acreage within the mechanically marginal ground will move into the late-open vegetation class following treatment. Treatments within the mid- and late-open classes will enhance and maintain the existing open structure of these areas and will not shift the distribution of these vegetation classes.

The table below provides a summary of the anticipated distribution of vegetation classes within the UMC project area after treatments are completed. The “Existing” field is the current distribution of vegetation classes for the forest type for the entire UMC project area. The mechanically feasible and mechanically marginal treatment acres are combined in the “Treatment acres” field. The “Outside of treatment” field corresponds to all of the acreages within the forest type that lie within the UMC project area boundary but do not fall within either the mechanically feasible or mechanically marginal designations. The “Post treatment” field is the anticipated distribution of vegetation classes after the project is complete, and the percentages of this distribution can be compared to the natural range of variation (NRV) in the final field of the table.

Table 17. Lodgepole pine forest distribution summary.

Class	Early	Mid-closed	Mid-open	Late-open	Late-closed	Total
Existing (ac)	76	871	662	543	1,360	3,512
Treatment acres (ac)	17	838	618	420	1,001	2,894
Outside of treatment (ac)	59	33	44	123	359	618
Post treatment (ac)	591	671	662	677	911	3,512
Post treatment (% of total)	17	19	19	19	26	100
NRV (%)	20	20	20	15	30	100

Gambel Oak-Mixed Montane Shrubland

Under the proposed action approximately 826 acres would be available for mechanized treatment and there are no identified acres of marginal mechanized ground for this ecological system. While the main goal in other forest types is to reach a vegetation class distribution that more closely follows a natural range of variation, the desired condition for the oak-mixed montane shrubland is to establish fuel breaks while creating more favorable structural conditions and age distributions.

Treatments within this forest type would be implemented to break up dense the mid-closed vegetation class that is found mostly within WUI areas of the project. The mid-closed vegetation class has developed after fire events and currently makes up the majority of this forest type. Treatments would typically utilize group selection methods and would create small openings (<1 to 5 acres) within these areas to begin to build in some diversification in age classes, protect any remnant ponderosa pine trees and large rare oak trees, and to break up ladder and understory fuel continuity. It is anticipated that treatments could move all of the mid-closed vegetation class into the early vegetation class.

Riparian swales

Under the proposed action approximately 3,940 acres would be available for treatment within mechanically marginal ground and there are no identified acres of feasible mechanized ground for this ecological system.

Treatments within this ecological system would seek to enhance riparian vegetation by thinning conifer encroachment within aspen clones, cutting or girdling decadent aspen clones to encourage the development of a new vigorous cohort, reducing the density of understory and mid-story conifers to reduce ladder fuels, pruning dominant overstory trees to raise the crown base height, and would release large conifers within stream channels from competing vegetation to increase the vigor of these rare features.

Thinning treatments would reduce the overall potential for passive and active crown fire in these areas and would increase the overall vigor of the residual overstory trees. Maintaining and enhancing the aspen component will lower the overall crown fire potential of these areas as aspen is inherently less flammable and capable of carrying crown fire when compared to conifers. Regenerating aspen clones in specific locations where clones are decadent or where additional age classes are needed to help perpetuate healthy aspen clones will benefit riparian areas. Aspen clones provide shade to riparian corridors, strengthen stream banks with root development, serve as sediment and debris filters from upland sites, and provide woody debris that adds to stream channel structure and function.

Reducing the density of understory and mid-story conifers and ladder fuels will reduce the active crown fire potential and potential independent torching that could kill large conifers within riparian areas. Similarly, raising the crown base height of large riparian conifers by pruning will lessen torching potential and limit damages caused by crown scorch from surface fires. By protecting and improving the vigor of large streamside conifers treatments will maintain important overstory trees to provide shade for riparian areas and will also provide a source of coarse woody debris for stream structure as these trees eventually die and fall.

Treatments are anticipated to shift the vegetation class distribution for this ecological system in all classes but the early class. Both the mid- and late-closed classes are expected to have a reductions in canopy cover that will move approximately 50 percent of the existing acreages in these classes into their respective open classes. In addition treatments within the mid-open class are expected to raise the average diameter of treated areas so that half of these acres will move into the late-open vegetation class.

Table 18. Riparian swale distribution summary.

Class	Early	Mid-closed	Mid-open	Late-open	Late-closed	Total
Treatment acres	16	2,617	935	8	364	3,940
Post treatment	16	1,309	1,776	658	182	3,940

Cumulative Effects

Completion of the UMC project, the Palmer Lake project, and projects recently completed on Air Force Academy lands will increase the overall complexity of the UMC landscape. These projects will tie into previously completed treatments on along the western edge of the UMC project area and will decrease the potential for active crown wildfire to carry across the landscape. A substantial barrier to crown fire spread will be established along the western boundary of the Roadless area in the norther portion of the project area.

Summary of Effects

The proposed action will have a substantial effect on the UMC project area. Spatial heterogeneity will increase at both the stand level as well as the landscape level as small and large scale openings are created. These openings combined with newly created fuel breaks and an overall reduced level of forest fuels will significantly impact the ability for uncharacteristically severe crown fire to spread in treated area. Reduction in uncharacteristic crown fire potential will benefit watershed health and function and have positive downstream effects to community water source protection.

At the stand level, thinning treatments will increase the vigor of residual trees, enhance important grouping structure, protect old rare overstory trees, remove much of the unnatural shade tolerant species, maintain and enhance the aspen component, increase the amount of non-tree understory vegetation, and shift age distribution so that stand development is more sustainable in the long-term.

Treatments will move toward a more balanced distribution of vegetation classes that will allow for ecological systems to better persist on the landscape. This complex mosaic of vegetation classes will limit the potential impacts from disturbances such as severe wildfire and epidemic pest outbreaks and will be more resilient should these disturbances occur.

Riparian treatments will increase the vigor of remaining vegetation, protect the rare structural features that define many of these areas, and will maintain the ecological integrity and hydrological function these systems provide to watersheds.

Increases in vigor in forest vegetation at the tree, stand, and landscape scale will place the UMC landscape in a better position for dealing with changes in future climate.

The mosaic of forest structures and openings within the UMC project area and in surrounding treated areas will allow for fire to play a more natural role in this landscape. By allowing fire to play a more natural role on the landscape, either through prescribed burning or natural ignitions, much of the fine and landscape scale heterogeneity will be maintained or increased. Forest floor vegetation and fuels can be moderated to prevent unnatural build ups of either. Passive crown fires and torching can remove additional overstory trees thereby adding to interspatial heterogeneity and creating new openings for tree regeneration. Tree regeneration that successfully recruits into the overstory will be governed by the stochastic nature of fire driven mortality. All of these effects combined will continually shift vegetation classes and forest type distributions in a way that is more representative of historic conditions and will perpetuate the role of fire on the landscape.

Monitoring Recommendations

Monitoring is routinely done during project layout, implementation, and post-implementation by Forest Service personnel to determine if silvicultural prescriptions were achieved and to determine if all specialist design criteria were followed. However, the desire to implement an adaptive approach to implementing the UMC project requires a more robust and intense monitoring protocol be utilized to meet the adaptive intent.

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